GEF

UNDP/GEF PROJECT ENTITLED "REDUCING ENVIRONMENTAL STRESS IN THE YELLOW SEA LARGE MARINE ECOSYSTEM"

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for the Fisheries Component
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National Data and Information Collection Activity - Final Reports

The activities to collect national fisheries data and information from China and Republic of Korea were initially reviewed at the 2nd RWG-F (17-20 November 2005, Busan, Republic of Korea). Since then, the draft final reports and data have been submitted, and these data are being used for the regional synthesis and Transboundary Diagnostic Analysis (TDA).

The contractors for the national data collection activity were the Yellow Sea Fisheries Research Institute (China) and the West Sea Fisheries Research Institute of the National Fisheries Research & Development Institute - NFRDI (Republic of Korea). One representative from each contracted institute will present the final results to the 3rd RWG-F Meeting. The reports attached hereafter, and the presentations given during Agenda 5.1.1 should highlight fisheries status and trends of particular note, and include some summary analyses on the collected data and information.

After reviewing the reports and presentations, participants will discuss the information just presented, and suggest how certain relevant data and information could be included in the regional synthesis and TDA.

The members of the he RWG-F will be invited to suggest what data of particular interest should be included in the regional synthesis and TDA, and the suggestions on how those inputs should be included. It should be noted that the final reports from the participating countries and the regional syntheses will be published by the project. The members will be invited to consider the revising, editing and publishing of the reports.

UNDP/GEF PROJECT ENTITLED "REDUCING ENVIRONMENTAL STRESS IN THE YELLOW SEA LARGE MARINE ECOSYSTEM"

Report of DATA AND INFORMATION COLLECTION FROM CHINA

by

Yellow Sea Fisheries Research Institute

2006

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REVIEW OF DATA AND INFORMATION COLLECTION FROM CHINA

1 BACKGROUND

Based on the tasks listed in the Statement of Work issued by the PMO (Contract No. CONOIA32201datacollect), the major tasks for the data and information collection including following requirements before the 2nd meeting of the Regional Working Group:

- Reviewing and collecting the actual data and information for each parameter
- Providing the location(s) of available databases
- Describing the status of commercial fisheries,
- Describing the current state-of-knowledge of fisheries carrying capacity
- Describing the existing status and trends of Mariculture
- Describing existing national laws and regulations on fisheries and Mariculture
- Listing the gaps in data and information required for understanding changes in the condition of fisheries
- Submitting a report to describe the fisheries problems

2 DATA AND INFORMATION

Data collection in the Bureaus of Ocean and Fisheries of Liaoning, Shandong, Jiansu Province and in Beijing were carried out along the coastal areas of the Yellow Sea listed below.

2.1 Fisheries data

- Landing of major species from China Fisheries Yearbooks, and provincial fisheries statistics, including: small yellow croaker (*Larimichthys polyactis*), Spanish mackerel (*Scomberomorus niphonius*), anchovy (*Engraulis japonicus*), chub mackerel (*Scomber japonicus*), herring (*Clupea pallasii*), largehead hairtail (*Trichiurus lepturus*), sandlance (*Ammodytes personatus*), actes (*Acetes chinensis* and *A. japonicus*), fleshy prawn (*Fenneropenaeus chinensis*), squids (*Todarodes pacificus, Loligo sp*. and *Sepia sp*.)
- No. Boats, by province from China Fisheries Yearbooks, and provincial fisheries statistics, including: Jiangsu,Liaoning, Shandong, Hebei, Tianjin
- HP of boats, by province from China Fisheries Yearbooks, and provincial fisheries statistics, including: Jiangsu,Liaoning, Shandong, Hebei, Tianjin
- % Species of catch from China Fisheries Yearbooks, and provincial fisheries statistics,: small yellow croaker, Spanish mackerel, anchovy, chub mackerel, herring, sandlance, fleshy prawn, actes, squids.
- Growth pattern, by species from published papers, books and monographs, including: small yellow croaker, Spanish mackerel, anchovy, chub mackerel, herring, largehead hairtail, sandlance, fleshy prawn, *actes*, squids.

- Reproduction, by Species from published papers, books and monographs, including: small yellow croaker, anchovy, Spanish mackerel, chub mackerel, herring, largehead hairtail, sandlance, fleshy prawn, *actes*, squids.
- Spawning Season, by Species from published papers, books and monographs, including: small yellow croaker, Spanish mackerel, anchovy, chub mackerel, herring, largehead hairtail, fleshy prawn, *actes*, squids.
- Migration pattern by species, spawning and nursery areas by species from published papers, books and monographs, including: small yellow croaker, Spanish mackerel, anchovy, chub mackerel, herring, largehead hairtail, sandlance, fleshy prawn, *actes*.
- Survey data from Yellow Sea Fisheries Research Institute of Chinese Academy of Fishery Sciences

2.2 Mariculture data

- Cultured area per region (province, habitat) per annum: Jiangsu, Liaoning, Shandong, Hebei, Tianjin
- Cultured weight per species (or kinds of organisms) per annum: shellfishes (eg. scallop, clam, etc.), fish, algae by species
- Abundance and distribution of important species in mariculture: shellfishes (eg. scallop, clam, etc.), fish, algae by species

2.3 Social economic data from China Fisheries Yearbooks and provincial fisheries statistics

- Vessels by Region
- Number of Fisherman by Region
- Fisheries Income
- Fishery Consumption Per Capita
- Fishery Export and Import
- Economic Importance of Fisheries (Employment, GDP Contribution)
- Legislation information
- Law of Fishery of PR China
- Implementation detail of Law of Fishery of PR China
- Provincial regulations for fisheries management and conservation
- Other laws and regulations related to fisheries
- Management and conservation measures
- Fisheries agreement

3 DATA ANALYSIS AND REVIEW

3.1 General information

The Yellow Sea is located at temperate and subtropical zones bordered by China, South Korea, North Korea, covering a large continental shelf with an area of c. 380,000 km^2 and an average depth of 44 m. A dividing line between the Yellow Sea and the East China Sea is commonly drawn from the mouth of the Yangtze River to Cheju Do. The coastline on the Chinese side of the Yellow Seas, from the estuary of the Yalu River and along Liaoning, Hebei, Tianjin, Shandong, and Jiangsu provinces, reaches about 4,400 km with a mud flat area of 9,000 km^2 in the Yellow Sea large marine ecosystem.

The Yellow Sea and Bohai Sea as one large marine ecosystem (LME) is located at temperate Zone. The number of species is much less than other seas. There are about 300 fish species, 41 crustaceans and 20 cephalopods in this region. Warm-temperate species are more dominated than warm-water species among the fishery species. There are few cold-temperate species in this region. In the central part of Yellow Sea, a basin with a depth of 70-80m, so called Yellow Sea depression, is an ideal overwintering ground for most migratory species. The coastal waters along the Yellow and Bohai Seas are the main spawning grounds for both migratory and local species.

Based on the distribution, the fishery resources in the LME can be divided into local and migratory resources.

The local species are mainly distributed in those shallow waters of estuaries and in vicinity of islands and reefs, the animals of the local resources usually move within a limited bound, for instance, seasonally move between deep and shallow waters for reproduction, feeding and wintering. Usually, the obvious pattern of the migration is seldom observed. There are a number of species of this group. They are mainly warm-temperate species like jellyfish (*Rhopilema esculenta*), Acetes shrimp (*Acetes chinensis*), blue crab (*Portunus trituberculatus*), tongue fish (*Cynoglossus semilaevis*), mullet (*Liza so-iuy*), sea bass (*Lateolabrax japonicus*), skate (*Raja* spp.), goby fish (Gobiidae), greenling (*Hexagrammos otakii*), Pacific Ocean perch (*Sebastodes fuscescens*), croaker (Collichthys), jewfish (*Johnius belengerii*), common asohos (*Sillago sihama*), Pacific herring (*Clupea pallasi*) and Pacific cod (*Gadus macrocephalus*) etc..

The migratory species mainly consist of the warm-temperate and warm-water species conducting long distance migration on a certain pattern and distributing widely. During the spring seasons, when the water temperature is increasing, the species migrate from the central-southern part of the Yellow Sea and the northern part of the East China Sea to the Bohai Sea and the coastal shallow waters of the Yellow Sea for spawning. After the reproduction peak in May and June, most species leave the shallow waters and disperse in the waters with 20 to 60 m depth for feeding until summer. During autumn seasons when the water temperature is decreasing, the fish schools gradually move to the deeper waters with a depth of 60-80m and higher temperature for wintering. The species diversity of the migratory resources seems less than that of the local resources, but their biomasses are much more abundant. The catches in the LME are mainly from the migratory species. The main commercially important species include Spanish mackerel (*Scomberomorus niphonius*), chub mackerel (*Scomber japonicus*), pomfret (*Stromateoides sinensis*), Japanese anchovy (*Engraulis japonicus*), half fin anchovy (*Setipinna taty*), Chinese herring (*Ilisha elongata*), small yellow croaker (*Larimichthys polyactis*), yellow drum (*Nibea albiflora*), fleshy prawn (*Fenneropenaeus chinensis*), southern rough shrimp (*Trachypenaeus curvirostris*) and squids *etc.*

In recent years, the most commercially important species is listed in Table 1, and their growth parameters are given in Table 2.

Table 1. List of commercially important species for fisheries statistics data

Common Name	Scientific Name	Chinese Name
Small yellow croaker	*Larimichthys polyactis*	小黄鱼
Spanish mackerel	*Scomberomorus niphonius*	蓝点马鲛
Anchovy	*Engraulis japonicus*	鳀鱼
Chub mackerel	*Scomber japonicus*	鲐鱼
Largehead hairtail	*Trichiurus lepturus*	带鱼
Pacific herring	*Clupea pallasii*	鲱
Sandlance	*Ammodytes personatus*	玉筋鱼
Acetes	*Acetes chinensis* and *A. japonicus*	毛虾
Fleshy prawn	*Fenneropenaeus chinensis*	中国对虾
Squids	*Todarodes pacificus*, *Loligo* sp. and *Sepia* sp.	头足类

Table 2. Growth parameters by species

Species		Growth Pattern					Remarks
Common Name	Scientific Name	L_∞ (cm)	k	t_0	$W=aL^b$	Longevity (yr)	
Small yellow croaker	*Larimichthys polyactis*	33	0.17	-2.5	$W=1.4835\times10^{-5}L^{3.03}$	23	
Spanish mackerel	*Scomberomorus niphonius*	71	0.53	-0.70	$W=1.8\times10^{-5}L^{2.85}$	7	
Anchovy	*Engraulis japonicus*	16.3	0.2	-0.8	$W=4.0\times10^{-3}L^{3.09}$	4	
Chub mackerel	*Scomber japonicus*	42.5	0.53	-0.80	$W=0.798\times10^{-5}L^{3.078}$	8	
Largehead hairtail	*Trichiurus lepturus*	55.3	-0.2928	-0.4106	$W=3.025\times10^{-5}L^{2.8806}$	7/10	
Pacific herring	*Clupea pallasii*	30.5	0.66	-0.198	$W=7.938\times10^{-6}L^{3.02}$	9	
Sandlance	*Ammodytes personatus*	No data available			$W=1.906\times10^{-3}L^{3.17}$	3	
Acetes	*Acetes chinensis* *A. japonicus*	No data available			W♀=0.0065L2.9888 W♂=0.0005L3.0787	1	
Fleshy prawn	*Fenneropenaeus chinensis*	19.1	0.47	0.54	$W=11.06\times10^{-6}L^{3.0015}$	1	W♀ = 11.0×10^{-6}L W♂=11.3×10^{-6}L$^{2.9}$
Squids	*Sepiella maindroni*	No data available			$W=1.0381\times10^{-3}L^{2.5396}$	1	
	Todarodes pacificus	28.6	0.37	0.2	$W=4.0\times10^{-5}L^{2.9064}$	1	
	Loligo japonica	No data available			$W=3.98\times10^{-4}L^{2.527}$	1	

Source: sandlance from Chen (2004), other species from Deng and Zhao (1991)

World aquaculture production now accounts for 32% of total fisheries production, according to “The State of Food and Agriculture 2005,” a report published by the Food and Agriculture Organization (FAO) of the United Nations. Most of the expansion has been attributable to China, which is now responsible for more than two-thirds of total aquaculture production in terms of volume (32 million tonnes in 2004). Yellow Sea fishery area is the most important fishery production area in China, where provides more than half the total production in many species (Table 3 and Table 4).

Aquaculture area of marine farmed species in 2004 and the overview of farmed production for last 10 years (from 1995 to 2004) in the area of the Yellow Sea is shown in Table 3 and Table 4.

Table 3. Aquaculture area of marine farmed species in 2004 (unit: ha)

Kind	species	Province					
		Tianjin	Hebei	liaoning	Jiangsu	Shandong	total
Finfish	subtotal	662	4865	5696	4015	9112	24350
Crustacean	Fleshy shrimp(Fenneropenaeus chinensis)	429	5907	12835	12900	6823	38894
	Kuruma shrimp(Penaeus japonicus)	631	11246	6714	1368	29774	49733
	Pacific white shrimp(Litopenaeus vanname	1925	3553	4680	3458	13635	27251
	Blue crab(Portunucs trituberculatus)				514	43	557
	others	1242	1867	1977	8224	29846	43156
	subtotal	4227	22573	26206	26464	80121	159591
Shellfish	*Crassostrea gigas*		121	9775		14894	24790
	Rapana venosa				35213	4167	39380
	Haliotis discus hannai			366	1	4167	4534
	Cyclina sinensis		32030	100213	73316	71129	276688
	Solen spp.		215	3020	11571	13310	28116
	Scapharca broughtonii		4453	45667	2063	2358	54541
	Mytilus coruscus		757	3196	14	17004	20971
	others		14495	151551	726	79853	246625
	subtotal		52071	313788	122904	206882	695645
Seaweed	*Porphyra spp.*				12071	1017	13088
	Laminaria japonica			5111	77	20539	25727
	Undaria pinnatifida			7012		232	7244
	Gelidium amansii					23	23
	others			1322	0	501	1823
	subtotal			13445	12148	22312	47905
Others	*Stichopus japonicus*		104	38516		20426	59046
	Jelly fish		2000	5305		3078	10383
	others	472	120	4400	749	47637	
	subtotal	472	2224	48221	749	71141	122807
Total(ha)		5361	81733	407356	166280	389568	1050298

Table 4. Overview of annual mariculture production for last 10 years

		Total production (M/T)				ratio %(YS/TSW)	ratio %(YS/(TFW+TSW))
year	kinds	YS	TFW	TSW	TFW + TSW		
1995	finfish	257	865,276	8,828	874,104	2.91	0.03
	crustacean	7,065	9,948	10,048	19,996	70.31	35.33
	shellfish	161,847	3,188	188,859	192,047	85.70	84.27
	seaweed	16,082		30,486	30,486	52.75	52.75
	others	858		1,021	1,021		84.04
	total	186,109	882,323	239,242	1,121,565	77.79	16.59
1996	finfish	32,677	11,883,291	182,155	12,065,446	17.94	0.27
	crustacean	38,278	364,441	88,851	88,851		43.08
	shellfish	1,984,735		3,144,131	3,144,131		63.13
	seaweed	645,353		913,948	913,948		100.00
	others	1,213		7,265	7,265		16.70
	total	2,709,670	10,989,505	4,376,549	15,366,054		17.63
1997	finfish	33,395	11,150,994	254,979	11,405,973	13.10	0.29
	crustacean	55,521	143,512	161,601	305,113	34.36	18.20
	shellfish	3,002,358		6,510,978	6,510,978	46.11	46.11
	seaweed	632,295		961,356	961,356	65.77	65.77
	others	2,717		21,506	21,506	12.63	12.63
	total	3,726,286	12,366,559	7,910,429	20,276,988	47.11	18.38
1998	finfish	45,027	11,841,097	306,697	12,147,794	14.68	0.37
	crustacean	60,441	185,109	214,300	399,409	28.20	15.13
	shellfish	3,013,414		7,002,498	7,002,498	43.03	43.03
	seaweed	684,042		1,024,172	1,024,172	66.79	66.79
	others	4,996		52,736	52,736	9.47	9.47
	total	3,807,920	13,219,136	8,600,403	21,819,539	44.28	17.45
1999	finfish	48,186	12,583,952	338,805	12,922,757	14.22	0.37
	crustacean	72,081	250,998	266,395	517,393	27.06	13.93
	shellfish	3,521,605		7,934,771	7,934,771	44.38	44.38
	seaweed	756,287		1,172,838	1,172,838	64.48	64.48
	others	9,154		30,176	30,176	30.34	30.34
	total	4,407,313	14,219,740	9,742,985	23,962,725	45.24	18.39
2000	finfish	68,310	13,069,692	426,957	13,496,649	16.00	0.51
	crustacean	84,550	329,796	343,184	672,980	24.64	12.56
	shellfish	3,818,128		8,607,050	8,607,050	44.36	44.36
	seaweed	815,854		1,201,559	1,201,559	67.90	67.90
	others	15,169		34,115	34,115	44.46	44.46
	total	4,802,011	15,169,365	10,612,865	25,782,230	45.25	18.63
2001	finfish	95,434	13,616,091	494,725	14,110,816	19.29	0.68
	crustacean	109,217	414,494	457,078	871,572	23.89	12.53
	shellfish	4,142,765		9,112,435	9,112,435	45.46	45.46
	seaweed	799,110		1,214,810	1,214,810	65.78	65.78
	others	17,339		36,275	36,275	47.80	47.80
	total	5,163,865	15,949,588	11,315,323	27,264,911	45.64	18.94
2002	finfish	149,385	14,244,402	560,404	14,804,806	26.66	1.01
	crustacean	130,143	453,696	562,326	1,016,022	23.14	12.81
	shellfish	4,470,338		9,651,727	9,651,727	46.32	46.32
	seaweed	833,553		1,301,679	1,301,679	64.04	64.04
	others	34,467		52,301	52,301	65.90	65.90
	total	5,617,886	16,940,493	12,128,437	29,068,930	46.32	19.33
2003	finfish	126,959	16,211,134	519,157	16,730,291	24.45	0.76
	crustacean	134,118	1,065,028	661,174	1,726,202	20.28	7.77
	shellfish	4,556,462	179,771	9,853,207	10,032,978	46.24	45.41
	seaweed	876,245	5,777	1,383,790	1,389,567	63.32	63.06
	others	92,452	281,024	115,733	396,757	79.88	23.30
	total	5,786,236	17,742,734	12,533,061	30,275,795	46.17	19.11
2004	finfish	150,992	17,210,199	582,566	17,792,765	25.92	0.85
	crustacean	150,161	1,225,626	722,172	1,947,798	20.79	7.71
	shellfish	4,754,219	191,132	10,247,151	10,438,283	46.40	45.55
	seaweed	931,123	4,480	1,467,545	1,472,025	63.45	63.25
	others	51,923	288,535	147,615	436,150	35.17	11.90
	total	6,038,418	18,919,972	13,167,049	32,087,021	45.86	18.82
grand total		42,245,714	129,786,459	90,626,343	227,025,758	443.64	183.27
Remark:	TSW: Total national production of mariculture						
	TFW: Total national production of fresh water						
	YS: Regional production of mariculture of Yellow Sea						

The yield of mariculture in the area of Yellow Sea accounts about half of total production of mariculture products of China (45-77%, varies to years).

The total seaweed yield in Yellow Sea area accounts more that half of the nation's total product (52-67%, varies to years). Shandong and Liaoning Provinces is the main producing area of kelp, especially in the former, whose production count for more than 60% of the total.

Another kind of main economic mariculture specie cultured in Yellow Sea area is shellfish, including oyster, clams, mussel and so on. The shellfish product has been very stable (totally accounts about 46% of the nation's yield) since 1996.

The ratio of the total production of crustacean in Yellow Sea area to the national production of crustacean has been decreased in recent years. For example, in 1996, the ration was 70.31%, while it become 43.11% in 1997, and from then on it has declined slowly year by year. In 2004, the yield of crustacean in the Yellow Sea area only accounted for 20.79% of the nation's total production in the species. The main reason of decline of production of crustacean is due to the increase of other kind of mariculture.

The finfish culture in Yellow Sea area only takes a small proportion of the total fish production. The ratio has increased from 2.91% in 1995 to 25.92% of the nation fishes mariculture production in 2004. The general trend shows rising with the passage of time year by year due to increasing demand of finfish the domestic markets.

3.2 Major Species

3.2.1 Small yellow croaker

Small yellow croaker (*Larimichthys polyactis*) is a warm-temperature bottom fish that are distributed in the Bohai Sea, Yellow Sea and East China Sea. The small yellow croaker is a slow growing species with a maximum age of 23 years (Liu *et al.*,1990). Three geographical stocks, the northern stock, the Lüsi stock, and East China Sea stock, are recognized (Liu *et al*., 1990, Jin, 1996a). The northern stock seasonally migrates between the central southern Yellow Sea (wintering) during winter and northern part of the Yellow Sea and Bohai Sea (spawning and feeding) from spring to autumn. The Lüsi stock is the bigger one and is distributed in the southern Yellow Sea (Fig. 1). It migrates seasonally relatively short distances, mainly between shallow and deep waters in the southern Yellow Sea. Small yellow croaker starts the spawning migration from the wintering grounds in March and arrives to spawn in the very shallow coastal waters of 10-20 m depth from April to May in the Yellow Sea and Bohai Sea (Liu *et al.*,1990; Kawasaki, 1987; Zhao, 1990). It is one of the most important food species to the Chinese and Korean coastal people, and has been exploited by bottom trawl fishery as an economically important target species over a half century. The total yield of small yellow croaker in the Yellow Sea and

Bohai sea reached about 200000 t in 1957. The fishing effort and fishing efficiency since then have increased rapidly and uncontrolled along with the fishery development that lead to the small yellow croaker population subjected to overfishing both inshore and offshore (Chikuni, 1985; Yu, 1991; Wang and Zhan, 1992, Jin, 1996a). The abundant spawners in the inshore had been caught along the Chinese coasts from the 1950s to the early 1960s and off the western coasts of the Korean peninsula in the 1960s. In the offshore the fish also were caught in abundance by the Japanese trawlers in the 1950s and 1960s (Kawasaki, 1987). A sharp decline in the stock size was reported also from Korean waters and associated with a decrease in the proportion of older fish in the catch (Hwang, 1977; Kim, 1977).

The stock size and yield of small yellow croaker has fluctuated considerably since the 1950s. Although it has been subjected to serious depletion, it still plays an important role in the Yellow Sea fishery, especially in the bottom trawl fishery, and it starts recovering in since 1990s (Jin, 1996b).

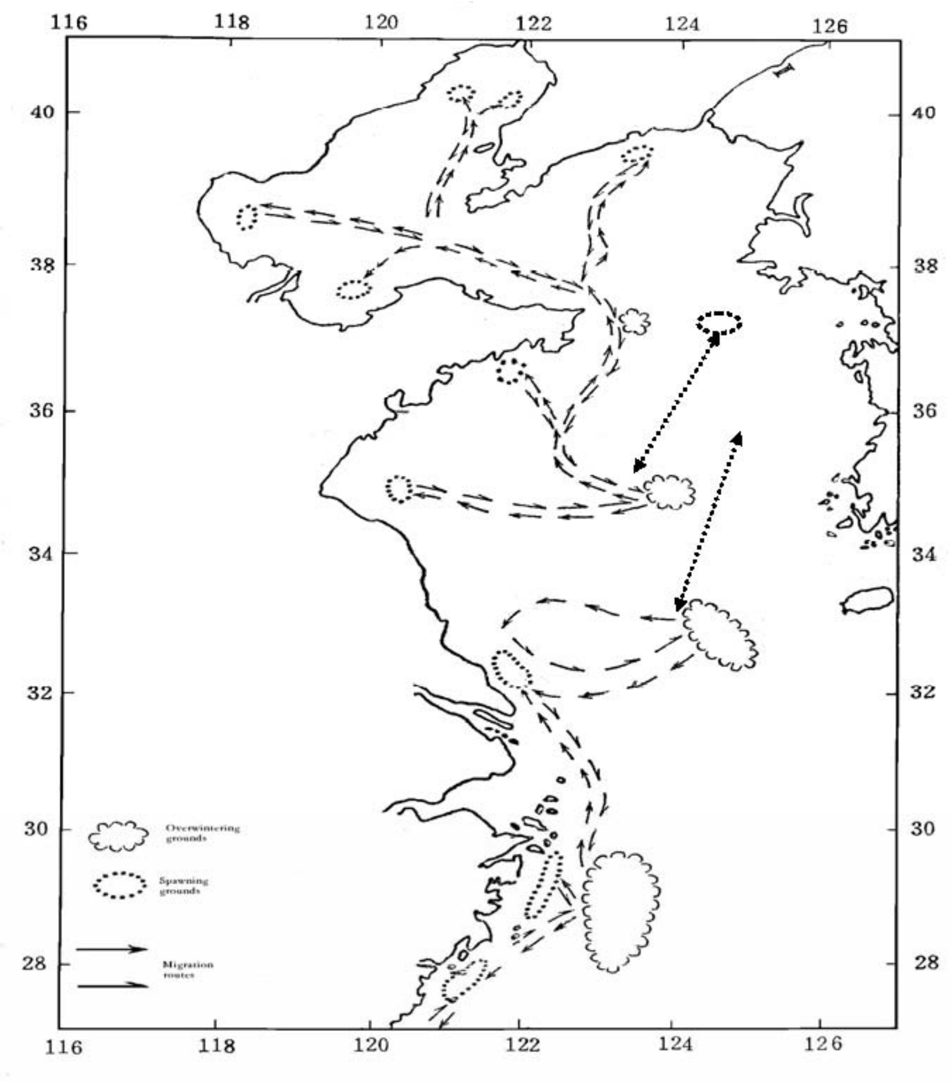

Figure 1. Migration of small yellow croaker (Adopted from Liu et al. 1990)

3.2.2 Japanese anchovy

Japanese anchovy is an inshore small pelagic species and widely distributed in the Bohai Sea, Yellow Sea and East China Sea, and migrates seasonally with changes in sea surface temperature. The optimum distribution temperature ranges from 10-13°C, and the anchovy is usually not distributed in the water below 7°C (Iversen et al., 1993). In November and December, the most dense area of distribution is at the northern and central parts of the Yellow Sea, and during the winter time, Japanese anchovy migrate into the southeast Yellow Sea and north East China Sea. As increase of water temperature and the development of gonads in spring, Japanese anchovy migrates into shallow coastal waters for spawning (Li, 1987). After that it disperses for feeding and moves into deeper and southern waters with decreasing water temperatures. After November, there are very few anchovy left in the Bohai Sea. Most dense schools are observed in the southeast Yellow Sea and north East China Sea.

The maximum age recorded in the Yellow Sea is four year old. Spawning areas of Japanese anchovy are found at nearshore banks and in bays along the Chinese coast. There are three major spawning areas observed: bays of the Bohai Sea, nearshore banks off south Shandong peninsula and off Zhejiang (southeast China) coast (Zhang *et al*., 1983; Zhu and Iversen, 1990).

According to the surveys by R/V"Bei Dou" from 1984 to 1988 (Zhu and Iversen, 1990), spawning season of Japanese anchovy is protracted from May to October, and the peak spawning period ranges from mid-May to late June at an optimum temperature of 14-18°C in the Yellow Sea. The 1-2 years old fish dominate the spawning stock. The ovulation belongs to multi-peak and continual type and spawn once a year, ie. ovulating as the egg is ripe without obvious resting stage in between (Li, 1987).

The annual landing of anchovy increased from 20,000 tons in 1989 to 640,000 tons in 1996, and more than 1 million ton in 1997 and 1998, becoming the highest landing among the single species fishery in China. However, the stock size has sharply declined based on acoustic surveys recently.

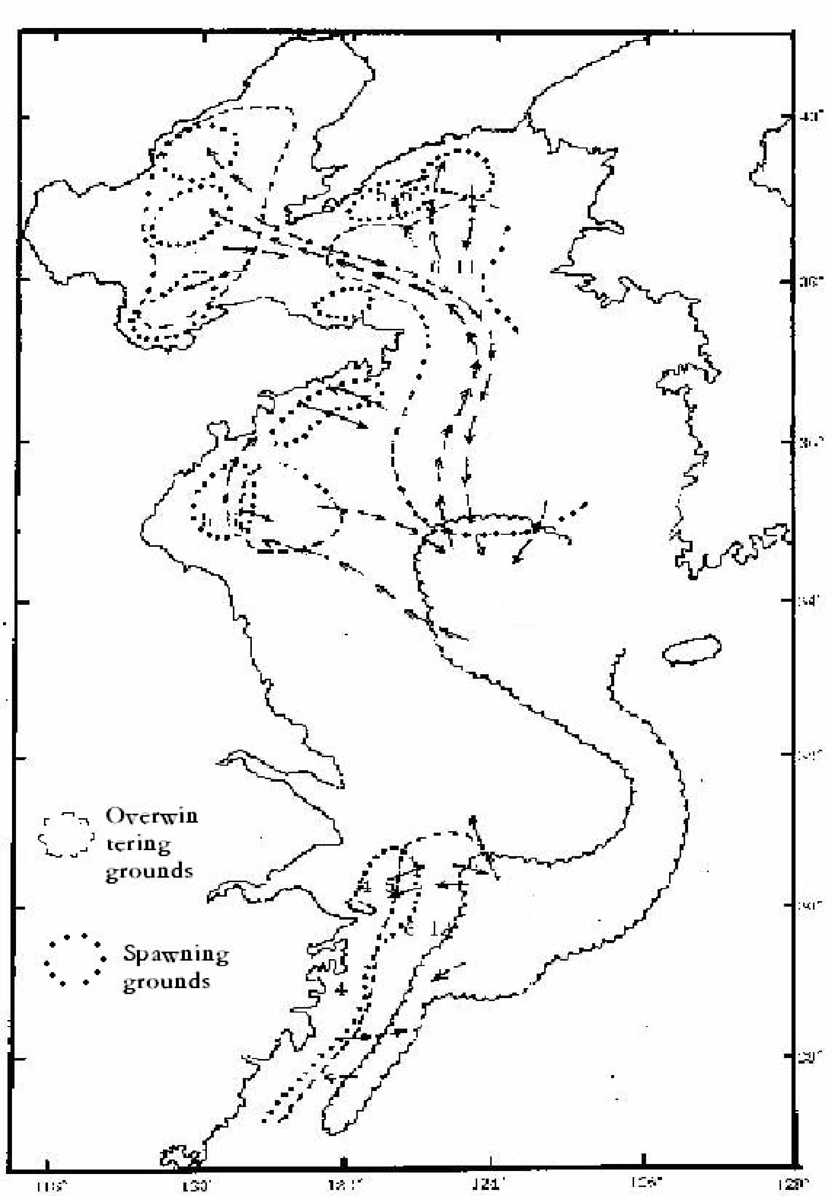

Figure 2. Migration of small Japanese anchovy (Adopted from Zhu and Iversen, 1990)

3.2.3 Pacific herring

Pacific herring in the Yellow Sea is a local stock which only inhabits the central to northern parts of the Yellow Sea (north of 34N) (Ye *et al.*, 1980). The Yellow Sea stock that was found in small quantity by the surveys in the 1950s widely occurred in the Yellow Sea in the late 1960s onwards. The wintering ground is in the central deep water. In February the mature population starts movement towards coastal water for spawning off the Shandong peninsula, and then migrates into the central and north of the Yellow Sea for feeding. The distributional area is reduced in autumn and further reduced in the central part of the Yellow Sea in winter (Tang, 1991).

The Yellow Sea herring start spawning in February in very shallow waters (3-7m) along the coast and bays around the Shandong peninsula, and small part spawner on the banks off the Liaodong peninsula and off west Korea (Fig.3). The main spawning season is from March to April with the requirement of water temperature and salinity of 0-5°C and around 30‰, respectively (Zhang *et al*., 1983). Tang (1980) found that the egg development of Yellow Sea herring exhibits a definite synchronism, and individual absolute fecundity increases linearly with increasing net body weight. Also half-fin anchovy spawns once in every reproductive season with a short period. But the herring eggs are sticky together and adhere to reef, algae and other substances. The hatching time decreases with increase of temperature from about 12-14 days at 5.5-10°C to 7-8 days at 15-20°C (Jiang and Chen, 1981; Zhang *et al*., 1983).

The fishery of Pacific herring in the Yellow Sea started at early 1970s, with the peak of 180,000 ton in 1972, and the catch decreased continuously since then (Tang, 1991). At present, it is difficulty to see herring from catches.

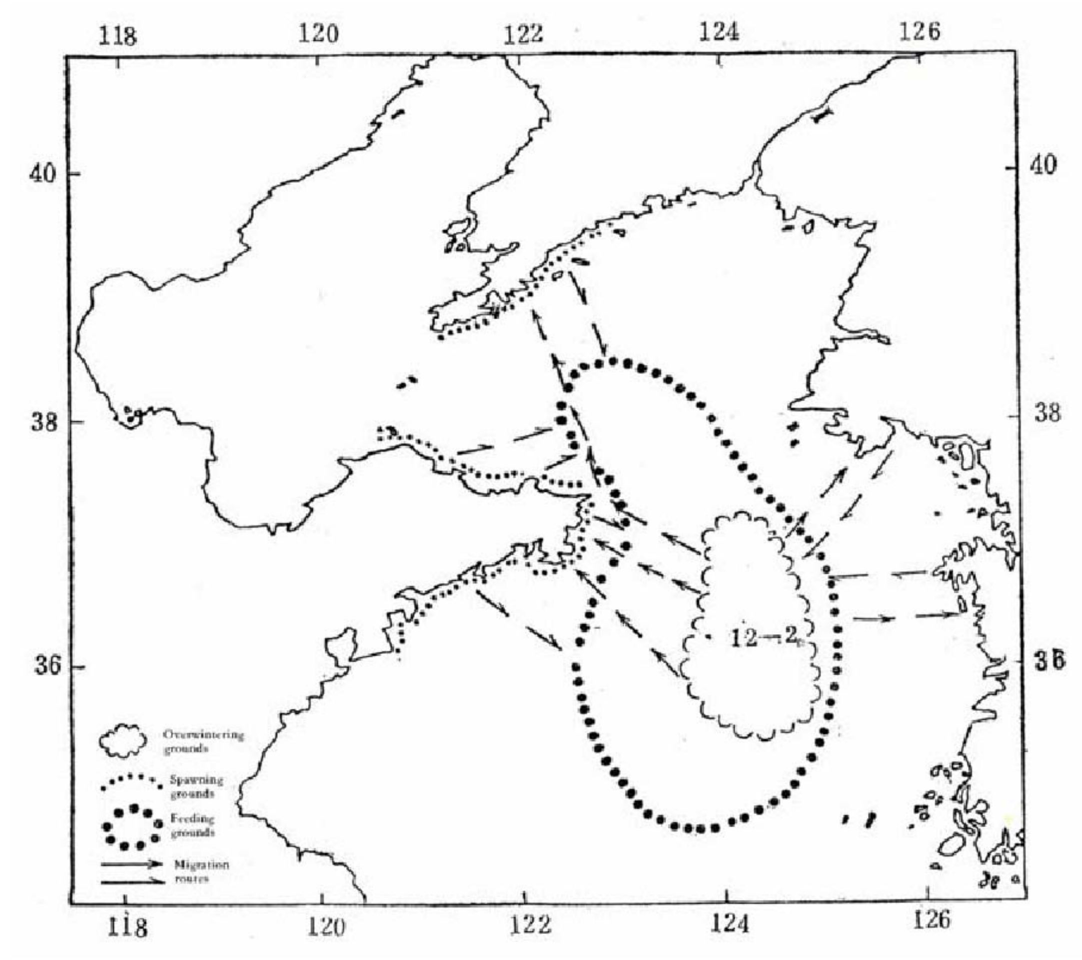

Figure 3. Migration of small herring (adopted from Tang, 1991)

3.2.4 Chub mackerel

Chub mackerel is a warm water fish which has two wintering grounds--one southeast of Cheju Do and one central to eastern parts of the East China Sea (Zhu *et al*., 1982; Wang and Zhu, 1983; Zhao *et al.*, 1990). The two stocks (Chikuni, 1985) start spawning migration along 12330'E at late March or beginning of April from the southern wintering ground, and along 3230' -3331'N one month later from the Cheju Do wintering ground to the Yellow Sea, respectively. The spawning mainly occurs in the south of Shandong peninsula from May to June. The feeding period is from July to September in the central to north of the Yellow Sea at relative deep waters. Then with the decreasing water temperatures, the population migrates southwards for wintering along 12400' -12500'E. However, the young populations (including 0 -group) mostly feed at the coastal waters off Korea from September to November (Fig. 4, Wang, 1991).

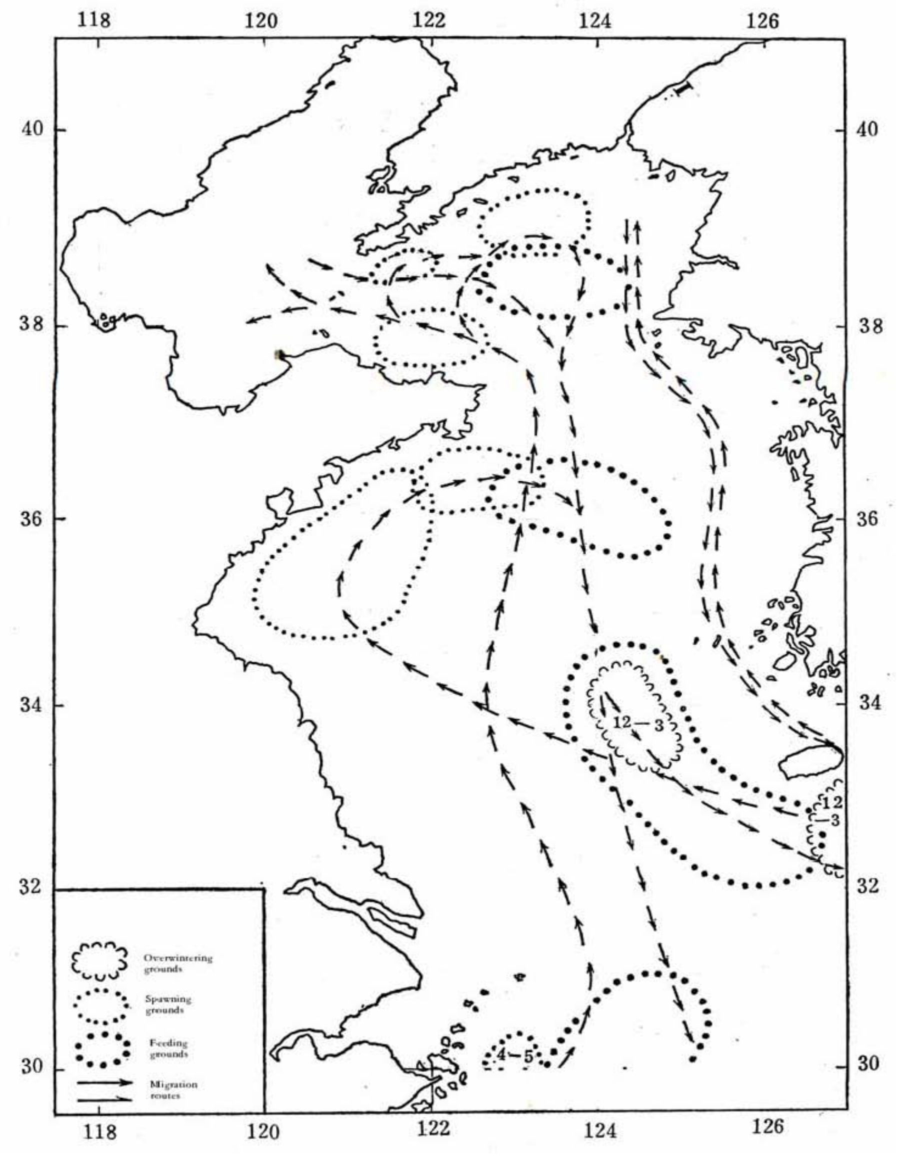

Figure 4. Migration of chub mackerel

Chub mackerel is a relatively long lifespan species with a maximum recorded age of 10 years old. The stock of chub mackerel in the Yellow Sea spawn around the Shandong peninsula from May to July. A small proportion sometimes enters the Bohai Sea for spawning. The temperature of the spawning areas is relatively high with an optimum of 12-17°C in the water off north Shandong peninsula and high salinity is needed (Zhang *et al.*, 1983; Wang, 1991). The fecundity of chub mackerel is quite high, and also increases linearly with net body weight (Liu *et al.*, 1990).

3.2.5 Spanish mackerel

Spanish mackerel is widely distributed in the northwest Pacific Ocean. The Bohai Sea, Yellow Sea and East China Sea are the major distributional areas of dense schools. There are two wintering stocks--southeastern Yellow Sea and offshore East China Sea (2800' -3120'N, 12340'-12530'E). The stock in the East China Sea spawns mainly in the Fujian (southest China) coastal waters and south of Shandong peninsula from April to May; the other stock spawns mostly in the Bohai Sea and the north Yellow Sea from May to June (Wei, 1991). After spawning, Spanish mackerel dispersively feed along the coastal waters. The distribution of this stock is strongly influenced by the water temperature, and migrates southwards with decreasing temperatures. Until November the main population is distributed in the central to south of the Yellow Sea, and starts returning to the wintering ground in December.

Spanish mackerel is the largest fishable pelagic fish in the Yellow Sea and Bohai Sea. The Yellow Sea stock spawn mostly in the bays of the Bohai Sea, some spawn along the coast of Shandong peninsula. The major spawning season is from May to June depending on the water temperature. The temperature of spawning areas differ greatly between south and north waters ranging from 9-13°C in the Bohai Sea and 11-20°C in the southern East China Sea, while the salinity is similar at 28-31‰ (Zhang *et al.*, 1983; Wei, 1991).

Spanish mackerel is an important target species in Chinese fishery, particularly in northern part of China. The landings show a increasing trend in the last 20 years.

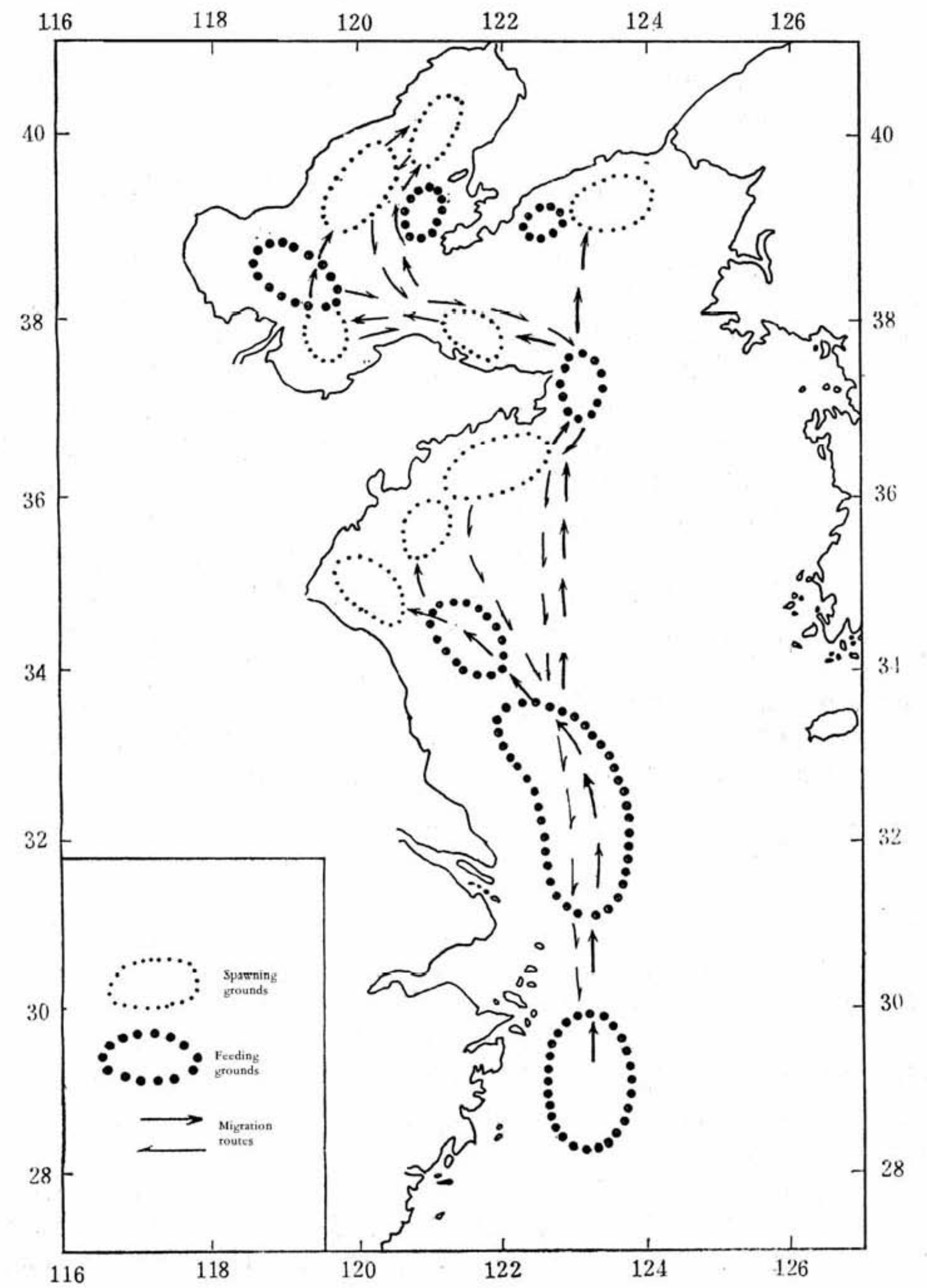

Figure 5. Migration of Spanish mackerel (adopted from Wei, 1991)

3.2.6 Largehead hairtail (*Trichiurus haumela*)

Largehead hairtail is a semipelagic species, inhabiting in the Bohai Sea, Yellow Sea, East China Sea and South China Sea, and is composed of two major populations, i.e. the Bohai Sea and Yellow Sea population and the East China Sea population. In addition, there are also some local populations in the South China Sea and in the shallow waters of Fujian Province and the Taiwan Strait. The maximum age recorded was 7 years old in the East China Sea. The spawning grounds of the Bohai Sea and Yellow Sea population are located in the coastal waters of the Yellow Sea and the three bays (Laizhou Bay, Bohai Bay and Liaodong Bay) of the Bohai Sea and overwinter in the central to southern Yellow Sea and northern East China Sea.

Largehead hairtail spawn in May and June in the Yellow Sea, and in June and July in the Bohai Sea. The spawning water is about 20 m depth, with bottom water temperature of 14-19℃ and salinity of 27-31.

Largehead haitail is the most abundant species in the East China Sea, has the highest single species catch in the East China Sea. The recruitment of the stock is in good condition, but the landing is mainly dependent on the young fish.

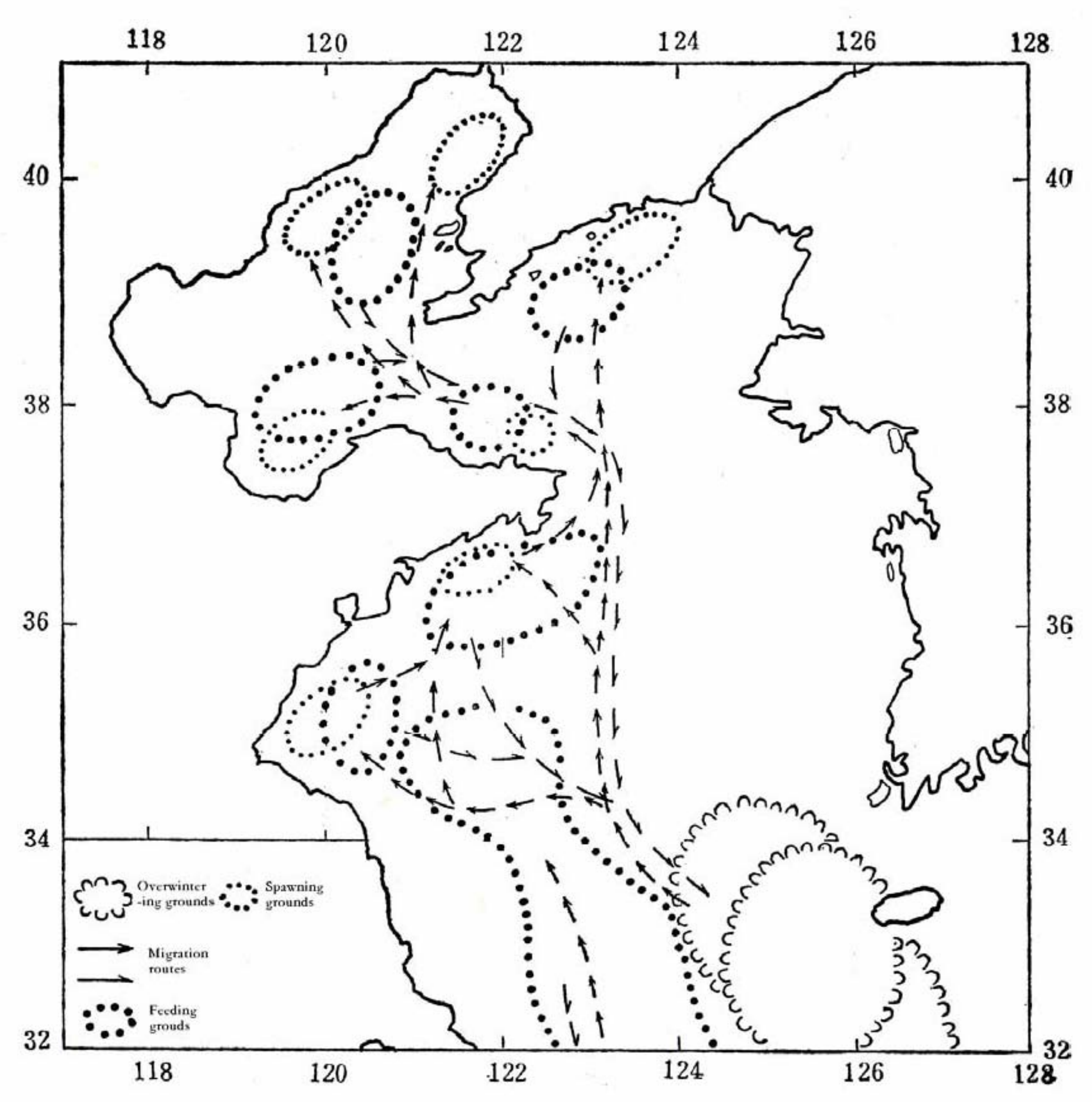

Figure 6. Migration of largehead hairtail (adopted from Liu et al., 1990)

3.2.7 **Sandlance (***Ammodytes personatus*)

Sandlance is a cold-temperate water, small-sized demersal species and mainly distributed in the northern part of the Yellow Sea. The majority of Sandlance mature during their first year of life and spawns once a year, mainly spawning from the end of October to December in the coastal shallow waters. The migration distance is short. In the earlier stage, the temperature for the spawners is about 11.8 ℃ and salinity is about 31.7. The individual absolute fecundity (eggs) ranges from 0.45×10^4 to 5.10×10^4. The length-weight relationship is $W = 0.001906\ L^{3.17039}$ (Chen, 2004).

Sandlance is a new target in Chinese fishery and the stock is believed to be in good condition although the landing varied in recent year.

3.2.8 Acetes chinensis

Acetes chinensis is the most abundant species in *Acetes*, which is only distributed in China, Korea and Japan, *Acetes chinensis* is one of the northernmost *Acetes* shrimps. In China, it is the most important species in the catch by fixed nets. It is distributed in the South/East China Seas and the Yellow/Bohai Seas. Centralized in the Bohai Sea and the coastal waters of Zhejiang Province in the East China Sea.

There are two generations in one year, i.e. Spring/summer (SS) and Summer/autumn (SA) generations. SS generation: During the overlapping of spring and autumn, the gonad of the broodstock is getting mature after wintering and starts to spawn in June. SS stock grows up quickly in summer seasons and starts to reproduce its offspring forming the SA generation. Most individuals of broodstock (both generations) die after reproduction. Therefore, the animals may undertake twice for reproduction in the lifetime and the longest life span only can be one year.

The mating activity takes place about 15 days prior to spawning. The spawning takes place in batches and always in night. The relationship between fecundity (O) and body length (absolute fecundity): $O = 0.0309L^{3.62}$, Here, O is the egg numbers; L is the body length-mm. The unit weight of egg (relative fecundity): 36.6 eggs/mg.

The stock of *Acetes* is in a good condition with varied in landings from Chinese catches, but shows an increasing trend.

3.2.9 Fleshy prawn (*Fenneropenaeus chinensis*)

Fleshy prawn was the most commercially important species in the Yellow/Bohai Seas and the main fishing object of trawlers and drift nets in the history. The relevant studies and technical information are relatively comprehensive in comparison with other species.

Fleshy prawn is mainly distributed in the Yellow Sea and Bohai Sea, and can be discriminated into two geographic populations. One distributes in the west coastal waters of Korean Peninsula; the other one distributes both in the Chinese coastal waters of the Yellow Sea and the coastal waters in the Bohai Sea (Deng, *et al.*, 1990). These two populations have their own spawning and feeding grounds, but the over-wintering grounds for these two population seem to overlap in the central part of the Yellow Sea. Fishery biological studies (size of stock abundance, body length distribution and the recapture of tagging release) showed that the geographic distribution and the reproduction of these two populations are insular. For the group distributing in the Chinese coastal waters of the Yellow Sea and the coastal waters in the Bohai Sea, during its life span, the animal migrates along a route about 1000 km long. The wintering ground covers a large area of 33°00' to 36°00' north latitude. In the second half of March every year, it begins to northwards in schooling with the northward movement of the isotherm of 6℃. On the way of the northward migration, the shrimps separate into two sub-groups, one moves towards the Haizhou Bay in the south coast of Shandong Peninsular and the other one towards the Haiyangdao Fishing Ground and the waters near the Estuary of Yalu River in Liaodong Peninsular for spawning. The former group passes round Chengshantou (Cape of Shandong Peninsular) and immigrates into the Bohai Sea through the Bohai Strait along the isotherm of 5℃ and in the last ten days of April the shrimps arrive at the vicinity to the estuary waters for spawning. As reported, the earliest and latest spawning timing is the 2^{nd} and 18^{th} of May respectively, when the water temperature rises above 13℃. The salinity of spawning ground ranges from 23.0 to 30.0‰. The fecundity is 0.5-1.0 million eggs and most of brood animals die after spawning. The young shrimp centralize in the coastal shallow waters for feeding and growing before the last ten days of June. By the last ten days of August when the average body length of the animals reaches 60-100mm, the animals move to the deeper waters. In September when the mean body length grows to 150mm, the animals move in batches to deeper waters than 20m. Normally, in the second half of October, growing up to an average body lengths of and 170-180mm (the female) and 150mm (the male) after last molting, the animals start to mate. Most male animals die after mating. In the second half of November when the bottom water temperature in the Bohai Sea drops to 12-13℃, Led by the female, the animals in groups emigrate out of the Bohai Strait. By the end of November, the shrimp school passes by the Cape of Shandong Peninsular southwards to the wintering ground. After reaching their wintering ground in the second half of the coming January, the shrimp school disperses.

The reproduction activities of the animals can be regarded as two separate periods. Mating activities take place in the middle of October and the beginning of November. During mating, the animals are mainly distributing in the relatively higher waters where the bottom water temperature ranges from 17 to 20℃. During this period, the cold air blows often and the cold wind blowing may activate the peak mating. The broodstock migrates to their spawning grounds to spawn. Normally, the water depth of the spawning grounds is less than 10m. The bottom water temperature and salinity in the spawning grounds ranges from 13 to 23℃ and 27 to31‰ respectively. But, the spawning timing is significantly different in the different spawning areas. For instance, in the Bohai Bay, the earliest spawning takes place on the 2nd of May and the latest on the 18th of May due to the sex gland develops with the increase of water temperature. The spawning season lasts about one month.

The techniques for the hatcheries of fleshy prawn in large scale were developed in the early 1980's, which have been made it possible to supply a great number of postlarvae for releasing and enhancement. The pilot hatchery releasing was conducted in some small bays like Liaodong Bay and Laizhou Bay in the Bohai Sea, and the southern waters off the Shandong Peninsular in 1981. The programs of the commercial hatchery release had been executed in those waters off the southern part of Shandong Peninsular, off Haiyang Island and the bays of the Bohai Sea since 1984 and resulted in a satisfactory feedback, particularly in the first two areas. 300-1,300 million juveniles (850 million per year in average) were annually released into the southern waters off Shandong Peninsular and the catch in autumn fishing season was increased by 1,625 tons in average. The maximal catch reached as much as 2,500 tons. The recapture rate ranged from 2.5% to 9.7% with an average of 5.5%. The annual releasing numbers were 160-2,100 million with an average of 1,220 million from 1985 through 1992 in the waters off Haiyang Island of the northern part of the Yellow Sea. The mean catch per year during autumn fishing season was increased by 2,168 tons with the highest record of 3,778 tons. The recapture rates were 4.0-13.6% and 7.0% in average. As estimated, the catch had been mainly contributed by the hatchery releasing during the period from August to October.

3.3 Fisheries

The marine capture and mariculture industries in five provinces/municipals (Liaoning, Hebei, Shandong and Jiangsu Provinces, Tianjin City) distributing along the western coast of the YSLME are relatively developed. Their captures have been operated not only in the Yellow Sea and Bohai Sea, but also in the East China Sea, particularly, Jiangsu province, the catches are mainly from East China Sea and distance waters. The landings of the ten most important species (groups) have been around 2 millions tons in recent years (Table 5), with an increasing trend. However, the largehead hairtail has been mainly caught from East China Sea by Jiangsu, Shandong and Liaoning provinces.

The fishing effort (number of boats and power) for the motorized boats had increased from 1986 to 1996 for ten years with the increased economic development in China, and steadily decreased in the recent ten years due to the strictly management measures introduced (see below), while the non-powered boats has showed a declining trend (Table 6), those boats were mainly used for mariculture with the increased mariculture in the coastal waters.

Table 5. Total catch by commercially important species

Year	Small yellow croaker	Spanish Mackerel	Anchovy	Chub Mackerel	Largehead hairtail	Pacific herring	Sandlance	Acetes	Fleshy Prawn	Squids	
1986	13,409	54,843	No data available	40,465	75,809	1,729	No data available	70,678	17,270	22,200	2
1987	16,806	61,047		51,111	73,383	3,354		62,598	9,932	19,869	2
1988	17,686	74,494		67,425	73,883	2,408		73,772	18,014	28,736	3
1989	12,939	75,743	20,035	58,738	85,256	798		82,409	7,952	16,289	3
1990	18,648	132,290	43,706	43,304	95,001	834		102,928	14,717	16,690	4
1991	36,412	115,508	68,495	64,031	111,770	1,065		99,937	10,377	14,339	5
1992	45,624	68,260	162,273	71,440	120,246	89		64,298	9,942	10,292	5
1993	58,717	66,073	272,923	75,885	111,033	0		107,007	5,946	15,740	7
1994	70,502	104,848	336,884	98,062	164,247	98		119,686	4,731	17,545	9
1995	110,620	99,448	426,326	164,598	203,118	564		172,829	4,610	31,915	1,2
1996	94,633	146,499	629,414	127,157	172,427	7		180,850	4,867	36,253	1,3
1997	76,129	178,145	1,037,682	131,971	138,673	365		197,234	5,889	39,134	1,8
1998	109,064	291,586	1,008,969	145,516	196,182	67		291,882	6,460	33,607	2,0
1999	141,529	284,713	893,493	158,542	219,317	54		256,818	7,687	33,338	1,9
2000	163,841	246,890	933,234	140,936	216,450	104		272,854	8,062	72,757	2,0
2001	155,088	227,583	1,050,178	133,343	209,337	No data available		275,302	6,536	40,323	2,0
2002	163,302	264,336	1,022,188	158,008	245,316			253,511	6,937	43,679	2,1
2003	155,062	257,637	1,060,687	156,844	237,960		195,216	235,500	7,114	26,974	2,3
2004	187,309	273,699	878,512	136,159	303,321		177,213	293,820	7,651	29,982	2,2
Mean	86,701	159,139	518,158	106,502	160,670		19,602	169,153	8,668	28,930	1,2

Data source: http://www.cnfm.gov.cn/ ; China Fisheries Yearbook (1999-2005); China Ocean Yearbook (1999-2004).

Table 6. Tonnage and KW of boats

Year	Powered Vessel			Tons/Vessel	Non-powered Vessel		Tons/vessel	Total		
	No.	Tons	KW		No.	Tons		No.	Tons	T/V
1986	45,930	729,585	1,246,490	15.9	29,125	55,570	1.9	75,055	785,155	10.5
1987	54,760	744,474	1,324,825	13.6	27,048	44,784	1.7	81,808	789,258	9.6
1988	64,174	837,716	1,510,385	13.1	27,080	45,527	1.7	91,254	883,243	9.7
1989	74,479	950,356	1,755,851	12.8	24,809	38,729	1.6	99,288	989,085	10.0
1990	77,395	981,782	1,820,732	12.7	24,591	36,027	1.5	101,986	1,017,809	10.0
1991	80,926	1,035,821	1,912,827	12.8	26,107	37,773	1.4	107,033	1,073,594	10.0
1992	84,823	1,094,392	2,000,925	12.9	34,924	50,535	1.4	119,747	1,144,927	9.6
1993	91,558	1,088,995	2,071,170	11.9	16,528	22,367	1.4	108,086	1,111,362	10.3
1994	96,700	1,026,503	2,010,422	10.6	17,089	23,282	1.4	113,789	1,049,785	9.2
1995	103,595	1,119,774	2,269,252	10.8	10,418	24,578	2.4	114,013	1,144,352	10.0
1996	106,377	1,192,369	2,507,739	11.2	10,469	14,447	1.4	116,846	1,206,816	10.3
1997	109,029	1,422,976	2,763,183	13.1	10,434	14,598	1.4	119,463	1,437,574	12.0
1998	107,200	1,412,312	2,855,994	13.2	8,065	11,551	1.4	115,265	1,423,863	12.4
1999	105,215	1,449,882	2,994,576	13.8	6,291	9,549	1.5	111,506	1,459,431	13.1
2000	107,137	1,432,413	3,093,720	13.4	11,607	12,801	1.1	118,744	1,445,214	12.2
2001	102,672	1,465,074	3,233,055	14.3	9,053	10,228	1.1	111,725	1,475,302	13.2
2002	98,278	1,467,304	3,113,978	14.9	11,359	11,851	1.0	109,637	1,479,155	13.5
2003	98,150	1,267,900	3,067,690	12.9	7,026	8,561	1.2	105,176	1,276,461	12.1
2004	96,273	1,396,002	3,133,497	14.5	7,103	10,235	1.4	103,376	1,406,237	13.6
Mean	89,720	1,163,981	2,351,911	13.1	16,796	25,421	1.5	106,516	1,189,401	11.1

Data source: http://www.cnfm.gov.cn/; China Fisheries Yearbook (1999-2005); China Ocean Yearbook (1999-2004).

3.4 Social economics

Total number of fishing boats operated in the coastal waters in China marine fisheries showed a decrease trends in recent years, while it slightly increased in the distant water fisheries (Table 7). This was due to one of the policy to control marine fishing effort implemented by China government with a special subsidy (see section 7.1).

The fishery is more important along the coastal waters than inland of China, which is fisherman's major income source for life. The fisherman engaging in fishing in the seas and inland waters was 1.82 million in 2004 (Table 8), slightly declined from previous years due to the governmental control policy (see section 7.1). The number of fisherman varied in the provinces along the Yellow Sea and Bohai Sea, Shandong and Jiangsu provinces were more than 0.2 million, while Tianjin was less than 6000.

The total fishery production of China was 49 million tons in 2004, including capture of 1.7 million tons (14.5 million tons from coastal sea and distance waters, 2.4 million tons from freshwaters), and aquaculture of 32.1 million tons (13.2 million tons from mariculture, 18.9 million tons from freshwater) in 2004, with a total value of about 38 billion Yuan, equivalent to 4.7 billion USD, a 35.2% increase from 2000 (Table 9). However, the total fishery value contributed to the GDP of 2.78-3.14% during 2000-2005, showing a decrease trend when China economy developed faster in other sectors. The consumption per capita was around 10 kg in recent years (Table 10).

Table 7. Vessels by Fishery

		2000	2001	2002	2003	2004
Total	Number	294,127	279,821	274,470	247,444	241,321
	Power Vessels	269,776	257,632	254,035	224,843	220,342
	Non-Power Vessels	24,351	22,189	20,435	22,601	20,979
	G.T	5,417,274	5,097,301	5,161,097	5,664,754	5,589,140
	Power Vessels	5,385,336	5,068,171	5,138,785	5,635,555	5,559,435
	Non-Power Vessels	31,938	29,130	22,312	29,199	29,705
Distant Waters Fisheries	Number	1,719	1,897	2,043	1,997	1,996
	G.T	704,369	723,303	701,362	714,514	758,644
Off-shore, Coastal Fisheries	Number	292,408	277,924	272,427	245,447	239,325
	G.T	4,712,905	4,373,998	4,459,735	4,950,240	4,830,496

Vessel by Province

Shandong	Number	43,302	41,529	39,775	3,1959	29,733
	G.T	609,874	619,302	639,832	680,526	640,132
Liaoning	Number	33,787	33,914	33,976	26,589	24,966
	G.T	352,799	390,038	414,425	463,112	460,194
Hebei	Number	8,858	8,413	8,159	7,166	6,710
	G.T	141,021	163,475	159,275	145,715	135,490
Tianjin	Number	1,131	1,146	1,009	992	851
	G.T	2,163	34,165	30,082	31,268	30,501
Jiangsu	Number	18,842	16,459	14,723	13,894	13,625
	G.T	332,137	301,466	248,956	261,293	260,901

Data source: http://www.cnfm.gov.cn/; China Fisheries Yearbook (1999-2005); China Ocean Yearbook (1999-2004).

Table 8. Number of fishermen by province

Unit: Person

		2000	2001	2002	2003	2004
No. of Persons		1,861,942	1,856,650	1,849,137	1,871,231	1,825,453
Province	Shandong	257,482	257,889	244,904	232,834	234,387
	Liaoning	136,172	141,181	143,564	149,020	140,673
	Hebei	39,157	37,712	37,063	36,624	46,900
	Tianjin	6,082	5,635	5,430	5,377	5,162
	Jiangsu	241,959	231,211	218,686	215,319	219,556

Data source: http://www.cnfm.gov.cn/; China Fisheries Yearbook (1999-2005); China Ocean Yearbook (1999-2004).

China has traded with about 150 countries in aquatic products. The total quantity was 5.4 million tons, valued of 10.2 billion USD in 2004 (Table 9), with an increase trend from 2000. The major export markets were Japan, USA, Republic of Korea, and EU, accounting for around 80% of total value and production. The exported items were mainly composed of deep processed products and frozen fish and fish fillets. The imported items were mainly fishmeal and raw materials for processing, from Peru, Russia, USA, Chile, EU, D. P. R. Korea, Norway, Japan in 2004. The major import and export provinces were Shandong, Guangdong, Liaoning, Zhejiang and Fujian, which all in the eastern China along the coast.

Table 9. Fisheries income [1]

Unit: $\times 10^9$ USD

	2000	2001	2002	2003	2004
Fisheries Income	35.10	36.60	38.88	41.54	47.45

Exports of Fishery Products

Unit: $\times 10^4$ ton

	2000	2001	2002	2003	2004
Total	153.4	195.3	208.5	210	242.1

Imports of Fishery Products

Unit: $\times 10^4$ ton

	2000	2001	2002	2003	2004
Total	252	231.4	249.1	233	298.6

Economic importance of fisheries (GDP contribution)

Unit: $\times 10^9$ Yuan

	2000	2001	2002	2003	2004
GDP	8940.4	9593.3	10239.8	11669.4	13651.5
Fisheries	280.8	292.8	311	332.3	379.6
GDP contribution	3.14%	3.05%	3.04%	2.85%	2.78%

Table 10. Fishery consumption percapita (kg) [2]

Unit: kg

Year	2000	2001	2002	2003	2004
Total(kg)	11.7	12.3	<13	9.3	10

[1] Data source: http://www.cnfm.gov.cn/ ; China Fisheries Yearbook (1999-2005); China Ocean Yearbook (1999-2004).

[2] Data source: http://www.cnfm.gov.cn/ ; China Fisheries Yearbook (1999-2005); China Ocean Yearbook (1999-2004).

4 STATUS AND TRENDS OF COMMERCIAL FISHERIES

The dramatic change among the pelagic fishes is Japanese anchovy in the Yellow Sea. There almost no anchovy fishery was carried out until the 1990s. The annual landings of anchovy linearly increased due to the increase of abundance and expanded exploitation in the sea. The annual landing of anchovy increased from 20,000 tons in 1989 to 640,000 tons in 1996, and more than 1 million ton in 1997 and 1998, becoming the highest landing among the single species fishery in China. However, these catches were highly over the half million ton of MSY, and the recruitment has sharply declined based on acoustic surveys recently. In the 1950's, the economically important species in the Yellow Sea and Bohai Sea were small yellow croaker (*Pseudosciaena polyactis*), largehead hairtail (*Trichiurus haumela*) and fleshy prawn (*Fenneropenaeus chinensis*) *etc*. With the increase of fishing effort, the abundance of these species declined one after the other. The pelagic fisheries were mainly targeted on Pacific herring (*Clupea pallasi*) in the Yellow Sea at early 1970s, with the peak of 180,000 ton in 1972, and the catch decreased continuously since then(Tang, 1991). At present, it is difficulty to see herring from catches.

The fleshy prawn fishery in the Bohai/Yellow Seas used to be composed of three fishing seasons i.e. autumn fishing season, winter-spring and spring fishing season. The Chinese fishing boats mainly operated in the autumn and spring fishing seasons in the Bohai/Yellow Seas. But Japanese trawlers operated in winter-spring fishing season in the Yellow Sea. Since 1962, the Chinese shrimp fishery has mainly been conducted in autumn fishing season, in which the catch might be 90% of the annual total catches. It is crucial that the recruitment be affected by the abundance of brood stock (spawners). The catches since 1990's have been decreasing sharply. The fleshy prawn fishery seems to vitally fade. The facts are that the abundance of the brood stock has been much less than the sustainable quantities for the said recruitment and the environmental conditions in spawning ground was changed.

Having been 300-year history in the Bohai Sea, *Acetes* shrimp fishery plays an important role in the China's marine fishery. For example, the average yearly catch of *Acetes* shrimp in the coastal waters of Zhejiang Province in the East China Sea was 60-80% of the total marine shrimp catches in this Province during 1980's. In the Bohai Sea, the average annual catch of *Acetes* shrimp was 60-70 thousand tons, which was about one-third of the total marine catches per year in the area. Being short of life span, the abundance of *Acetes* shrimp may be easily affected by natural conditions and human activities. As a result, its abundance fluctuates extensively.

In the 1980's, the stocks of some other pelagic fish like half fin anchovy (*Setipinna taty*), Japanese anchovy (*Engraulis japonicus*), chub mackerel (*Scomber japonicus*) and Spanish mackerel (*Scomberomorus niphonius*) seemed increasing to some extent. The yields of these pelagic fisheries (mainly chub makerel, scad, and Spanish mackerel) have continuously increased, from around 200,000 ton in early 1980s to 1.46 million ton in 1999, but the harvests were heavily dependent on juvenile and one-year-old fish.

Since the mid-1980's, the abundance of Japanese anchovy became the largest one among those pelagic species (Jin, 1996b). According to a ten-year surveys carried out by R/V "Bei Dou" from Yellow Sea Fisheries Research Institute, the biomass of

Japanese anchovy in Yellow Sea annually varied from 2.5 to 4.3 million tons, while cod, hairtail and fleshy prawn were seldom found in the catches. The annual landings of anchovy linearly increased due to the increase of abundance and expanded exploitation in the sea. The annual landing of anchovy increased from 20,000 tons in 1989 to 640,000 tons in 1996, and more than 1 million ton in 1997 and 1998, becoming the highest landing among the single species fishery in China. However, these catches were highly over the half million ton of MSY, and the recruitment has sharply declined based on acoustic surveys, showing that the abundance of Japanese anchovy is declining to about 0.2-0.3 million tons (Jin, 2003; Zhao *et al*. 2003), while the biomass of sandlance (*Ammodytes personatus*) is increasing and the stock of small yellow croaker showed a recovery indication. The landings of paste shrimps (*Acetes chinensis, Acetes japanicus*) and jellyfish (*Rhopilema esculenta*) have showed stable in the Bohai Sea and around the Bohai strait waters for many years, while swimming crab (*Portunus trituberculatus*) has been at very low levels recently.

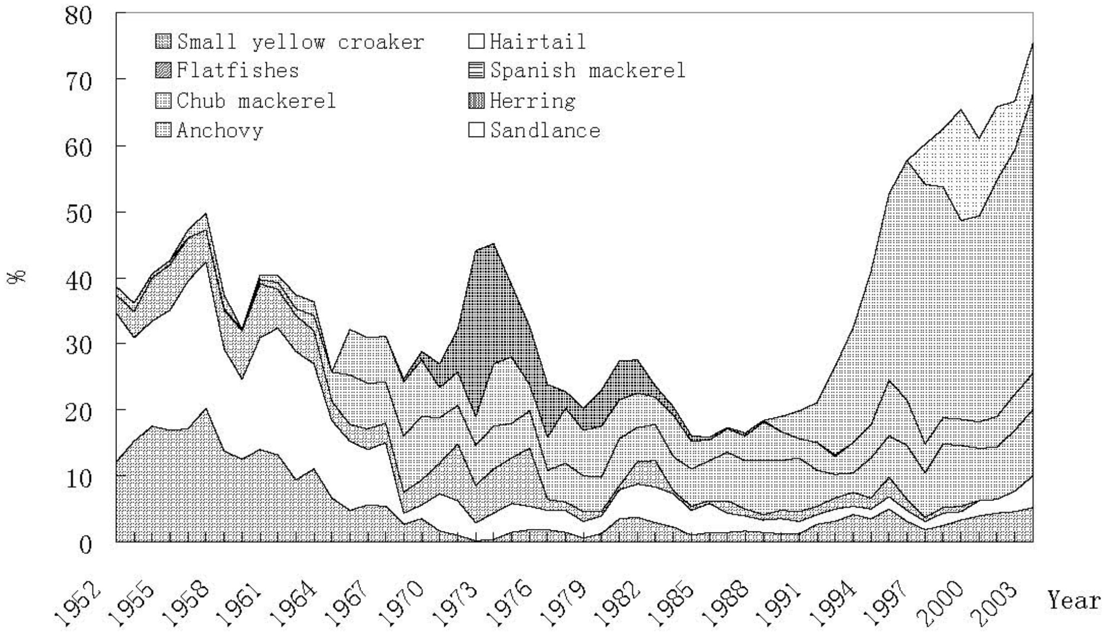

Figure 7. Species composition from Yellow and Bohai Seas

The dominant species were changed from 1959 to 1982 in the Bohai Sea, high valued, commercially important species such as small yellow croaker, largehead hairtail, and penaeid shrimp were replaced by low valued, small sized species such as Japanese anchovy, half-fin anchovy etc. Although the dominant species in some extent varied between years, the small pelagic fish, such as anchovy, half-fin anchovy and gizzard fish (*Clupanodon punctatus*) dominated the fishery resources since the beginning of 1980s. However, in 1998-1999, the biomass of most fishery species declined to a very low level, particularly the biomass of small pelagic fish and economic important invertebrate have sharply decreased with reduced distribution areas that directly affect the growth of carnivorous fishes, such as Spanish mackerel.

The abundances of the many economically important species have been depleted due to the change of environmental conditions and overfishing in the Yellow LME. The community structure changed considerably. The large-sized demersal species have been replaced by the low-valued and small-sized pelagic fish; early maturity and reduced spawning ground have been observed in some species (Jin, 1999, 2003, 2004).

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5 CURRENT STATE-OF-KNOWLEDGE OF FISHERIES CARRYING CAPACITY

An environment's carrying capacity is its maximum persistently supportable load (Catton, 1986), carrying capacity is usually defined as the maximum population of a given species that can be supported indefinitely in a defined habitat without permanently impairing the productivity of that habitat. The ecological analyses focus on the flows of available energy/matter from primary producers--green plants and other photosynthesizers -- to sequential levels of consumer organisms in ecosystems and on the return flows of degraded energy and material through biogeochemical cycling back to the ecosystem.

There are a quantity of methods and models to estimate maximum sustainable yield (MSY) of single species and carrying capacity of marine ecosystem. For example:

- *Production models (e.g.Schaefer model)*
- *Ricker Models*
- *Beverton-Holt Models*
- *VPA, MSVPA*
- *Trophodynamic method: B=q·En*
- *Ecopath*

Due to the concept of carrying capacity is wide that can be estimated by many methods, It is used more popular in aquaculture today. ECOPATH with ECOSIM (EwE) method (Christensen and Pauly, 1992; Christensen, et al., 2004; Pauly et al., 2000, Walters etc., 2000) might be used in the later stage of the project, these models describe ecosystem resources and their interactions and may use to:

- *Evaluate ecosystem effects of fishing (incl. indirect effects, e.g., through habitat modifications);*
- *Evaluate effects of environmental change;*
- *Predict bioaccumulation of persistent pollutants;*
- *Evaluate impact and placement of marine protected areas;*
- *Evaluate uncertainty in the management process;*
- *Explore management policy options incorporating economic, social, legal, and ecological considerations;*

EwE has been widely used for estimating carrying capacity of marine ecosystem, but they need many data to input and many uncertainties. In spite of the problems of seasonal averages and migration, manipulating an ECOPATH model balanced on a yearly time scale can be a source of useful insights into ecosystem structure and function. For example, a modeler may use ECOSIM to examine the factors that control the carrying capacity of a species, trophic level, or ecosystem in the presence of driving forces that vary in time at the scale of years or decades.

6 STATUS AND TRENDS OF MARICULTURE

6.1 Mariculture status

The production of the principal mariculture organism started with the seaweeds in China rather than shrimp and fish. This is because the seaweeds are autotrophic and have relatively simple life histories whereas the shrimp and fish are heterotrophic and have complicated life histories. Mariculture in China may date back to the Song Dynasty about 1000 years ago, cultivating a kind of seaweed called glueweed, *Gloiopeltis furcata*, by a simple rock-cleaning method in Jinmen near Xiamen, Fujian Provence (Tseng, 1933). The same method was later applied to seaweed, called zicai or purple laver, Porphyra haitanensis, in Pingtan County on Haitan Island, also Fujian Province. The molluscs are in the middle; they are heterotrophic but many of them are plankton feeders and have simple life history. Oyster cultivation must have existed in China for a long time, probably more than 1000 years and records of about 400 years old have been found. Cultivation of other mollusks such as the razor clam must have been in existence for a few hundred years. The gangyang or 'inlet cultivation' of the fish *liza so-iuy* and the shrimp *Penaeus chinensis* in the coastal region of Tianjin has a history of perhaps 200 years. In recent years, more and more species of seaweeds, mollusks, shrimp and fish have been introduced from foreign countries (Tseng, 1993).

Thus, mariculture in China has had a long history. Up to the middle of 1990's, kelp still led in the mariculture production at 231,300 tons, and the total seaweed production, at 241,300 tons. We call this the 'seaweed era' in Chinese mariculture. In 1986, however, mariculture of the mussel led the production, at 210,700 tons against 203,400 tons of Japanese kelp, and the total mollusk production was 438,000 tons, accounting for 51% of the total mariculture production. Therefore, the 'mollusc era' arrived and we are still at this situation now. Scientists predict that fish and shrimp should be the leading products of mariculture and this era will definitely come (Tseng, 1993).

In the past, the seaweeds, molluscs, shrimp and fish were cultivated under traditional methods which were very inefficient, for example, in 1950 total production was only 10,000 tons. In the traditional methods, natural 'seeds', including spat and fry were employed in seaweeds. In 1952, the kelp, *Laminaria japonica*, was cultivated with sporelings grown from spores collected on artificial substrate. This was followed by the cultivation of purple laver, *Porphyra* spp. Commercialized in 1963, mussels *Mytilus galloprovincialis* in 1972, the local scallop *Chlamys farreri* in 1973, the shrimp *Penaeus chinensis* in 1979, the bay scallop *Argopecten irradians*, in 1985 (Tseng, 1993); now is turning to flat fishes, especially turbot and flounder.

6.1.1 Seaweed

Scientific aquaculture in China started with the kelp *Laminaria japonica* in 1952 (Tseng, 1981). At the earlier stage, like all other mariculture organisms, natural sporelings of kelp were used, and growth of the young sporelings took place on sublittoral rocks. After several years of research, palm ropes in the form of rafts were used for collecting spores in twisted on larger ropes and hung in the sea for cultivation. For a long time, China has been the greatest producer of Japanese kelp in the world, production amounting to as much as 801,128 tons dry kelp per annum. Shandong and Liaoning Provinces is the main producing area of kelp, especially in the former, whose production count for more than 30% of the total. During the past years from 1993 to 2004, the wet kelp produced from the both Provinces is stable at 400,000 tons every year.

Following kelp cultivation, purple laver cultivation has been successful in China. China produced some *Porphyra* by traditional methods of rock cleaning for a few hundred years. In China, large-scale cultivation of the species were conducted with a improvement of the traditional Japanese pillar method of cultivation in 1952 (Tseng, 1989). The main producing area of purple laver is one of the Yellow Sea coastal Province, Jiangsu, which counts for more than 80% of the total production in China and the production is about 10,000 tons per year.

Besides *Laminaria* and *Porphyra*, several other seaweeds also have been subjected to cultivation, such as *Undaria pinnatifida* and *Hizikia fusiformis* among the brown algae, and *Gloiopeltis furcata*, *Gracilaria spp*., *Eucheuma gelatinae* and *Gelidium amansii* among the red algae (Tseng, 1993). In recent years, two microalgae have been cultivated, *Dunaliella salina* among the green algae and *Spirulina platensis* among the blue-green algae. Now there are more than twenty species and groups of seaweeds under culture. Among the species described above, two species attract more attentions for their economic characters, *Graciliara* spp. and *Spirulina platensis*. *Gracilaria* spp. (Rhodophyta) are important economic algae used for agar extraction, natural products with important bioactivity, edible market seaweed in some parts of the world, food binder for aquaculture, as well as efficient heavy metal container (Marinho-Soriano, 2001; Mazumder et al., 2002; Marinho-Soriano and Bourret, 2003; Freile-Pelegrín and Murano, 2005; Ye et al., 2005). Experiments prove that culturing by thalli farming can be successful in the coastal of Qingdao, Shandong Province, one of the Yellow Sea coastal Provinces, though, most of Graciliara production were produced from the South of China; *Spirulina platensis* is famous for its iatrical function and its culture area extend almost to the maximum in recent years.

6.1.2 Molluscs

The first mollusc to be submitted to mariculture in China was the mussel, *Mytilus galloprovincialis*. Note that in 1986, when the production yielded 210,057 tons of mussels, mussels overtook Laminaria as the no. 1 mariculture organism (Tseng, 1993). Two scallops have been subjected to mariculture, namely, the local scallop, *Chlamys farreri*, and the introduced bay scallop, *Argopecten irradians*. The fomer takes two years to mature and the latter only 1 year. Commercial production started in the early eighties. The bay scallop introduced from America was commercialized in 1985. In 1996, three species as *Argopecter irradians, Patinopecter yessoensis* and *Crassostrea gigas* were notarized as new species introduced from other countries. The total production of scallop in 2004 was 910,352 tons and 548,295 tons were from Shandong Province.

Three species of oysters are cultured: *Crassostrea rivularis* of Guangdong in the South China Sea, *Crassostrea* spp. of Fujian and Zhejiang in the East China Sea and *C. gigas* of North China in the Baohai Sea. During the past 20 years, most of spats have been successfully artificially bred by hatchery feeding and collected in a large scale.

6.1.3 Shrimps

Shrimp farming developed very slowly before the middle 1970's because of little support and low profits. Until in the late 1970's, to better promote shrimp culture in China, the State Fisheries Administration (formerly the Ministry of Fisheris) organized a joint research project on shrimp fry rearing. In the early 1980's, optimal conditions for temperature, water quality management and hatchery feed supply were intensively studied and techniques for industrial production of shrimp were developed (Liu, 1983).

Pond culture is the principal form of shrimp mariculture. The growout ponds are generally constructed by building embankments in the intertidal zone. In the case of raising shrimp larvae, quality management and adequate food supply are the important conditions for growth of cultured shrimps. Annual production of cultured shrimp in China has jumped from 450 tons in 1978 to 535,230 tons in 2004.

The most common species of shrimp under cultivation are the four species: *Penaeus vannamei, Penaeus monndon, Penaeus chinesis* and *Penaeus Japonica*. And the four species of shrimps cultured in the four Yellow Sea coastal Provinces, Liaoning, Shandong, Hebei and Jiangsu, amount to 92,079 tons in the year of 2004. A few other species, such as *P. penicullatus* and *P. merguiensis*, also are cultivated in South China. In North China, pond-cultured shrimp are fed mainly with live marine or brackish-water invertebrates.

6.1.4 Fishes

Fish mariculture in China has had a history of a hundred years, but it was primarily a rough cultivation method of enclosing the fry of the fish *Liza so-iuy* in enclosures together with the shrimp *Penaeus chinensis* at the beginning. In 1980, the area under cultivation was 16,733 ha but the production was very low, amounting to only 2600 tons, averaging 155 kg/ha. The chief production province is Guangdong with 34,933 ha in fish mariculture production, producing 28,000 tons or about 84% of the entire Chinese cultivation area in 1990. There was not a single dominant species of fish producing a sufficient amount to be specially recognized. Beginning in 1958, experiments achieved with mugli and more recently with the sea breams, *Pagrosomus* and *Sparus*, the flatfish, Paradichthys, and the grouper, Epinephalus. Besides, natural fry of the Japanese eel has been caught and reared (Liu and Zhang, 1991). In 2004, the total production had arrived 582,566 tons.

As for fish production merely, capture still accounted for the absolutely majority for 9,590,111 tons captured with the comparison of 582,566 tons cultured according to the statistics in 2004. However, he enormous increase in Chinese fishery production depended principally on aquaculture. In 1980, the total production of marine and freshwater aquaculture together constituted 30% of the total fishery production and was 43.8% in 1985 at the end of the 6th five-year plan. Again in 1988 was a memorable year, the first time account half of the total, 50.2% of the Chinese fishery production, another important milestone. And the ratio of marine fishery production was 47.6% in the year of 2004.

6.2 Mariculture trend

China is the leading aquaculture nation of the world, both when it comes to the number of species reared and volume produced. Traditionally fresh water culture has dominated, but in resent years the marine aquaculture has increased dramatically. This is partly due to the overexploitation of the natural fish stock in Chinese waters, which has forced many fishermen to change their profession to fish or shellfish farmers. The production of bivalves is the biggest mariculture industry in China but farming of fish is increasing. Like other countries, which have developed an intensive mariculture, China has experienced health and environmental problems. Both industries are faced with environmental issues such as accumulation of bio-deposition or fish feed and faeces and outbreaks of diseases, which may result in pollution, high mortality and low growth rates. In general the deterioration of the environment has negative effect both on the health and growth of mariculture organisms and on the natural habitat in the coastal zone.

Similar to other intensive mariculture regions worldwide, rapidly developed scallop culture and other mariculture industries in the last decade have overcrowded almost every potential culture site in shallow sea of China. As a consequence, low growth rate, high mortality and increased cost are challenging the sustainable development of mariculture industry in China. To find an effective or optimal culture model, which will not only yield high quality aquatic products, but gain ecological and social-economic benefits as well. Ranking all main culture species, polyculture models of seaweed +bivalves+fishes are deemed to be the best practices for mariculture in shallow sea areas in future.

Mariculture will continue expanding in China, which is also an important sources of seafood. Given improvements in fish feeds and disease control, further growth of the industry is possible. Exploiting aquaculture technology could assist the recovery of currently endangered stocks, molluscs and crustaceans as well as finfish. Sensitivity in marine farm site selection, with more offshore locations and the rotation of production could minimize the benthic impact and allow the seabed under fish farms to recover relatively quickly. The breeding of juveniles of species that can be released into the sea for the benefit of the wild fishery (e.g. lobsters and crabs), are also worthy of continued investigation.

7 ANALYSIS OF NATIONAL LAWS AND REGULATION ON FISHERIES AND MARICULTURE

The fishery resources are the basis of fishery development, and the environment of fishery waters is the basis of living for fishery resources and of fishery activities. The traditional fishery structure of China has taken fishing natural stocks as the principal thing for a long time, this irrational exploitation pattern has caused fishery resources depletion, and limited the development of fishery economy. In 1999, Chinese fisheries achieved a fundamental change from fishing to developing aquaculture, and became the first country that the yield from aquaculture was larger than fishing.

To meet the responsibilities to recent international treaties, conventions and agreements, notably the United Nations Convention on the Law of the Sea, and FAO's Code of Conduct for Responsible Fisheries. China government has issued and revised many new laws and regulations related to fisheries and taken many actions to control fishing effort and yield to conserve the living marine resources, including the YSLME.

7.1 Major laws and regulations related to fisheries

7.1.1 Fishery Act of the People' Republic of China"

The promulgation and enforcement of "Fishery Act of the People' Republic of China" was a milestone in fishery history and had large effect on the development of Chinese fishery in 1986, including chapters of aquaculture, capture, fisheries enhancement and conservation, and legal responsibility. "Implementation detailed rules of the Fishery Act" was made accordingly. Since then, the Chinese fishery has been the fast development period. The Fishery Act as a legal provision defined a suitable fishery development policy to China's conditions. It has been significant important to the adjustment of fisheries production relationship, to standardizing of fisheries activities, to conservation and rational utilization of fishery resources. This law has brought Chinese fisheries onto the right track of developing and managing fisheries based on the law.

From the Fishery Act to present, the central and provincial governments have issued various laws and regulations more than 500 documents, which are related to all aspects of fisheries, and have primarily formed the legal system frame of Chinese fisheries.

On 1 December 2000, a revised the Chinese Fishery Act approved by the National People's Congress of China went into effect which increases punishment for illegal fishing and lays the legal foundation for a quota management system.

According to the principle defined by the Fishery Act, China strengthened the building of law enforcement officials. There are about 30,000 fisheries inspectors, 1500 enforcement vessels, including 481 marine enforcement vessels in 2003.

7.1.2 Marine Environmental Protection Act of the People's Republic of China

This Act went to effect in April, 2000, in order to protect and improve marine environment, protect marine resources, prevent pollution damage, maintain ecological balance, ensure human health, promote sustainable development in economy and society. The chapter of "marine ecological protection" is highly related to fishery resources, particularly in protection of spawning grounds, nursery grounds and over-wintering grounds, and major migration routes.

7.1.3 Breeding and Protection Act of Fishery Resources

As early as in 1957 the former Ministry of Aquatic products promulgated a Regulation of Breeding and Protection of Fishery Resources (draft). It was a first trial to identify fishery resources for protection. In 1979 the State Council officially issued the Breeding and Protection Act of Fishery Resources, in which 26 marine species of fishes, 7 species shrimps and crabs, 14 species of molluscs, 6 species of algae, and 10 species of mammals including were listed as protected species. More detailed protection rules were stipulated by provinces (autonomous regions/municipalities) according to their own specific conditions.

7.1.4 Conservation Regulation of Living Resources in the Bohai Sea

This regulation was enacted by Ministry of Agriculture based on "Fishery Act of the People' Republic of China" and "Marine Environmental Protection Act of the People's Republic of China" in order to protect, enhance and rationally use the living marine resources and to protect the ecological environment in the Bohai Sea, to ensure the fisherman's rights and interests, to promote sustainable development of Bohai Sea fisheries. It went into effect on May 1, 2004, and replaced the "Regulation of fisheries resources breeding and conservation" in 1991. The regulation set down the key protected species and their minimum landing size, minimum mesh size, and the closing seasons for each fishing gears which operated in the Bohai Sea.

7.1.5 Regulation on administration and management of aquatic seedling production

The regulation was first issued by Ministry of Agriculture of People's Republic of China on 12 December 1996. The regulation was emended and reissued by Ministry of Agriculture on Dec 8, 2000. The regulation standardizes the estate, facilities procedure in the culture, as well as the quality of the seedling. The main aspects are as follows:

1. Regulation on the examination and approval of native and excellent breeds.
2. Standard on the examination and approval of native and excellent breeds.
3. Brief introduction of species approved by the examination and approval committee of the nation.
4. Regulation on checking and accepting of the breeding factory.
5. Regulation on the administration of producing procedure.
6. Regulation on the administration of the project of breeding factory construction.

7.2 Fisheries Management Measures

China government promulgated and put into effect of many laws and regulations related to conservation of living marine resources and enhancement. Ban fishing lines for motorized trawlers along coastal waters, closed seasons and areas for major spawning grounds, and licensing, minimum mesh sizes regulations were put into effect since the 1950's. These have taken significant effect on conservation of fishery resources.

7.2.1 Fishing effort control

In 1981, Chinese government report on 'outstanding fishery problems' identified overcapacity as the overriding issue, and called for suppression of capacity growth through measures. In 1983, the government issued another statement calling for a stop to catch increases, stricter control over the increase of fishing boat numbers, protection and increase of inshore resources through artificial restocking, etc.

In 1987, a serious attempt to control effort was initiated by the central government.

In 1997, a 'double control' policy aimed at limiting both the number of boats and their power. In support of that policy, i.e., in an effort to better control inshore effort, the Ministry of Agriculture also had fishing permits reissued in all coastal provinces and cities.

In 1999, the Ministry of Agriculture issued new fishery structural adjustment guidelines, again emphasizing strict control of fishing effort, and aiming for catch reductions. The measures designed to reduce effort included:

- A stop on permissions to build new fishing vessels (except for distant water fishing purposes);
- A ‘comprehensive clear up of illegal boats’;
- A prohibition on the introduction of foreign boats to fish in the Chinese EEZ;
- The gradual establishment of a mandated vessel retirement system; and
- The strict prohibition for non-fishing laborers to take jobs in marine fisheries.

Presently, three official documents are required for engaging in fishing activities along the Chinese coast:

- A fishing vessel inspection document;
- A fishing vessel registration document; and
- A fishing permit.

In order to further reduce the fishing effort (fishing mortality), China government has arranged 270 million CNY each year to subsidizing of scrapping old fishing boats and to encourage fishermen to change their jobs during 2002-2004. Meanwhile, building new fishing boats have been strictly controlled. A plan of reduced 30000 marine fishing boats has conducted from 2002 to 2010.

In order to conserve and protect the fishery resources, China started completely closing fishing in the Yellow, Bohai and East China Seas for 2-3 months in summer since 1995. In 1999, 2.5 months in the region of north 35ºN, and 3 months south 35ºN, and two month in the continental shelf of South China Sea were used. These measures have effectively protected the juveniles so that the catches and quality have obviously increased and improved.

7.2.2 Output control

Taking the landings in 1999 as the maximum, thereafter, total marine catches should be equal or less than that in 1999 (zero growth policy). This policy stipulates that all levels of government and fishery administrative departments in each coastal provinces, are to take appropriate measures, based on local conditions, to guarantee the zero growth in marine catch, which changed the previous practice of aiming toward ever increasing catches. The zero growth policy continued in the year 2000 and thereafter, and Chinese government even seeks to reach “negative growth in marine catch”.

7.2.3 Mariculture

Firstly, current legislation and regulations require full implementation, where the following issues require completion or establishment:

- Standards for aquaculture production;
- The code for aquaculture operations;

- Quality standards for fish products;
- Environmental standards for fisheries, including water quality standards;
- Standards for rearing techniques.

Secondly, aquaculture systems and technologies should be developed in accordance with accepted ecological standards. Measures to promote the application of ecological standards and "green" products that have been reared in such systems should be the subjects of research and extension, giving focus on the supply of healthy, nutritious food. These are instruments that will assist the policies adopted for readjusting the market.

Thirdly, a licensing system for the discharge of sewage drain waters into fishery environments should be implemented where sewage could only be released after approval by the fishery environment monitoring department, which would be required to demonstrate discharge standards. Financial charges would be collected from those discharging sewage, the money to be used as a management fee to assist in:

- Production management,
- Technical renovation,
- Treatment of wastes and drainage waters, and
- Cleaning of pollution to protect or recover fishery environments.

7.3 Fishery Agreement between People's Republic of China and Republic of Korea

To conserve and rational utilization of marine living resources concerned, to maintaining normal operational order, and to strengthen and develop mutual cooperation in fisheries domain, the governments of People's Republic of China and Republic of Korea signed the Fishery Agreement on August 3, 2000, based on "UN Convention of the Law of the Sea", which became effective on June 30, 2001. This Agreement was applicable to both countries' EEZs, and established an **I**nterim **M**easure **W**aters (IMW) shared and managed by both countries. The IMW is inside the lines linked by the following points.

Latitude	Longitude
1. 37°00'N	123°40'E
2.36°22'23"N	123°10'52"E
3. 35°30'N	122°11'54"E
4. 35°30'	122°01'54"E
5. 34°00'	122°01'54"E
6. 34°00'	122°11'54"E
7.33°20'	122°41'E
8.32°20'	123°45'E
9.32°11'	123°49'30"E

10.32°11’	125°25’E
11.33°20’	124°08’E
12.34°00’	124°00’30”E
13.35°00’	124°07’30”E
14.35°30’	124°30’E
15.36°45’	124°30’E
16.37°00’	124°20’E
17.37°00’	123°40’E

A transition zone was set in each side of the IMW for four years from effective date of the Fishery Agreement (see below table). The transition zone no longer existed since 2005.

Chinese side		Korean side	
Latitude	Longitude	Latitude	Longitude
1.35°30’N	121°55’E	1.35°30’N	124°30’E
2.35°00’N	121°30’E	2.35°00’N	124°07’30”E
3.34°00’N	121°30’E	3.34°00’N	124°00’30”E
4.33°20’N	122°00’E	4.33°20’N	124°08’E
5.31°50’N	123°00’E	5.32°11’N	125°25’E
6.31°50’N	124°00’E	6.32°11’N	126°45’E
7.32°20’N	123°45’E	7.32°40’N	127°00’E
8.33°20’N	122°41’E	8.32°24’30”N	126°17’E
9. 34°00’N	122°11’54”E	9.32°29’N	125°57’30”E
10.34°00’N	122°01’54”E	10.33°20’N	125°28’E
11.35°30’N	122°01’54”E	11.34°00’N	124°35’E
12.35°30’N	121°55’E	12.34°25’N	124°33’E
		13.35°30’N	124°48’E
		14.35°30’N	124°30’E

8 IDENTIFY GAPS IN DATA AND INFORMATION

From the data and information collected, the gaps in data and information may be following.

1. The catch statistics by area, by species is not available.
2. Available publications and information in English are not enough.
3. Most of the data and information in mariculture is gathered and issued by the province, so the information and data is only on the province-level.
4. Since data collected have not come down to the details as culture methods concerned information about different habitant cannot be gathered.
5. The issues of mariculture habitats license are still on the schedule, which will be finished in the near future. Therefore, statistics data dealing with mariculture habitats licenses cannot be obtained now.

9 IDENTIFY THE MAJOR PROBLEMS OF THE FISHERIES AND MARICULTURE

Based on the above analysis, the following problems are identified:

1. Over-exploitation of target species and climate changes cause shift of dominant species, foodweb were down.
2. Insufficient monitoring, not enough scientific-based knowledge on status of stocks
3. Insufficient management and control of fisheries activities, over-capacity of fishing fleets
4. Expanding mariculture activities and over-exploitation of natural habitats lead to increase effect of mariculture activities on surrounding habitats, including limited suitable sites, concerns regarding negative environmental impacts, and multi-use conflicts. One problem is an intensive use of the natural coastal habitats and ecosystems for monoculture technology, which when exceeds the ‘carrying capacity’ of the area, might cause environmental degradation, disease outbreaks, and reduced growth. Another major problem is aquaculture’s contribution to the global issue of farming up the foodweb by using industrial fishing products to increase cultural production.
5. Increasing demand for marine resources due to rapid population and economic expansion
6. Poor regional coordination, communication and collaboration, insufficient financing mechanisms and support
7. Insufficient information and environmental impact assessments

10 PRELIMINARY CAUSAL CHAIN ANALYSIS

Problem	Impacts	Immediate Causes (Technical)	Underlying cause	Root cause	Governance
Decline of biomass in Many Commercially Important Fishery Species	*Reduction in trophic level, Reduction in overall size of some commercially valuable species.* *Change in composition of species*	*Over-exploitation of target species and climate changes*	Insufficient management and control of fisheries activities. Over-Capacity of fishing fleets, Insufficient monitoring and enforcement.	Increasing demand for marine resources due to rapid population and economic expansion	Insufficient implementation of national regulatory instruments; Lack of regional harmonization of regulations; Insufficient knowledge and infrastructure base.
Inadequate **control of Aquaculture Practices**	*Damage to coastal natural habitat;* *Damage to environmental quality;* *Introduction of pathogens;* *Increase in disease outbreak*	*Over-intensive aquaculture activities; and, Over-exploitation of natural habitats;* *Introduction of foreign species*	Increasing mariculture activities; Effect of mariculture activities on surrounding habitats	Increasing demand for marine resources (mariculture products) due to rapid population and economic expansion	Inadequate legal instruments at regional levels; Inadequate implementation of national regulatory instruments; Lack of regional harmonization of regulations.
Inadequate Capacity to Assess Ecosystem	*Incapacity to adequately manage activities and management resources, and mitigate effects*	Insufficient information and environmental impact assessments	Insufficient knowledge and infrastructure base	Poor regional coordination, communication and collaboration; Insufficient financing mechanisms and support	Insufficient understanding and associated policies

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Annex I: Fisheries Data
Annex II: Mariculture Data
Annex III: Social economic Data

UNDP/GEF PROJECT ENTITLED "REDUCING ENVIRONMENTAL STRESS IN THE YELLOW SEA LARGE MARINE ECOSYSTEM"

Report of DATA AND INFORMATION COLLECTION FROM THE REPUBLIC OF KOREA

by

West Sea Fisheries Research Institute

2006

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REVIEW OF DATA AND INFORMATION COLLECTION FROM THE REPUBLIC OF KOREA

1 BACKGROUND

The Yellow Sea is semi closed sea located to the north of the East China Sea. The sea is surrounded by the Republic of Korea (ROK) and the Democratic People's Republic of Korea (DPR KOREA) on the east and by the People's Republic of China (PRC) in the West, fronting the Bohai Bay in the PRC to the northwest. In the south, it is continuous with the East China Sea along the direct line connecting Jeju province, South Korea and the north bank of the Yangtze River, PRC. The Yellow Sea is about 417,000km^2 in an area (NFRDI, 1988, 1996).

The major feature of the Yellow Sea is the relative shallowness of the water. Most of the sea is characterized by an extensive continental shelf. The northern part of the Yellow Sea, the Bohai Bay has an average depth of only 21 m and a maximum depth of 72 m. For the rest of the Yellow Sea, the average depth is 44 m and the maximum depth is 103 m. Major current affecting the Yellow Sea are coastal current and part of the Kuroshio Current. The currents supply fertile nutrients to marine living resources in the Yellow Sea. Biodiversity of fisheries resources is high, with about 450 large species. Commercially important fisheries resources are about 50 species caught by Korean and Chinese fisheries (Lee, 2004; NFRDI, 1996; Yeon, 2001 Unpublished).

It has been generally considered that the Yellow Sea and the East China Sea are separated in terms of Large Marine Ecosystem (LME). However, considering that fish stocks migrate freely between them, the Yellow Sea may not be separated from the East China Sea in terms of the conservation and the management of fishery resources.

Except for some sedentary species, most fished species migrate seasonally for wintering, spawning and feeding. Wintering occurs in deeper water in the southern Yellow and Northern East China seas, and many fishes migrate to coastal areas for spawning and feeding from spring through autumn. Both the Yellow Sea and its coastal zones are thus components of a large ecosystem, and resources in each area have to be managed with this in mind (NFRDI, 1988; Yeon, 2001 Unpublished).

Most commercially valuable fish stocks in the Yellow Sea have been overexploited due to both a continuous increase in fishing capacity in adjacent coastal states and near shore fish habitat deterioration because of large land reclamations, municipal and industrial waste discharges. Korean and Chinese fishermen have increased competitively their fishing effort as their landings have decreased, it has accelerated the depletion of fish stocks in the Yellow Sea (Yeon, 2001 Unpublished).

While traditional fisheries resources in the Yellow Sea show generally decreased and landings of small pelagic fishes have on average increased, a reduction of fish size in the landings suggests that these stocks are also now being significantly impacted (NFRDI, 1996; Yeon, 2001 Unpublished).

According to stock assessments, most demersal fish resources appear to be overexploited, although some short-lived pelagic species like anchovy may have a little room for further exploitation (NFRDI, 1996; Yeon, 2001 Unpublished).

Due to the natural resources decreased, mariculture was considered like to compensate the reduction of the products from the natural resources. At first mariculture products increased, but recently it started decreased, and it has been restricted by the license system etc.

Therefore, it is necessary to establish collaborative management system among the countries to utilize the resources and ocean effectively. However, until now there haven't been any opportunities to carry out comprehensive and partnership studies to understand the Yellow Sea ecosystem and to set up cooperative strategies to reduce the ecosystem stress in the Yellow Sea associatively among the countries.

Thus, first of all, collection of data and information on fisheries, mariculture and socio-economic issues in ROK and the PRC is conducted through the Yellow Sea Large Marine Ecosystem (YSLME) Project to consider what is going on the sea closely. A Transboundary Diagnosis Analysis (TDA) can be then developed with the available info followed then by the Strategic Action Plan (SAP) between ROK and the PRC. Currently, no information is available to distinguish the landings off the Yellow Sea from those off the East China Sea. However, the Yellow Sea catches have mostly been landed at Yellow Sea-located pots, such as ports in Inchon, Gyeonggi, Chungnam, Jeonbuk and Jeonnam Province. This means that fishery information for the Yellow Sea was obtained from the western ports of Korea.

The major tasks for the data and information collection activity are:

- Reviewing and collecting existing data and information for each parameters as the listed in the agreed data table during Working Group 1, 2
- Providing the locations of available database
- Describing the status of commercial fisheries
- Describing the existing status and trends of mariculture
- Describing the existing national laws and regulations on fisheries and mariculture
- Describing the collected socio-economic data and information
- Listing the gaps in data and information required for understanding changes in the condition of fisheries, mariculture and socio economic

2 DATA AND INFORMATION

2.1 Fisheries Data

We visited a total of 11 institutions including five provincial governments, three research institutes and three universities to collect and investigate data and information related to fisheries resources, and visit websites related to fisheries statistics (Refer Section VIII, Fig. 11).

The commercially important landing data by species and year were collected by Fisheries Statistical Yearbooks and each provincial fisheries data, but, in the case of Jeonnam province (Jeollanam-do), we had to estimate landing data from the two local provincial governments (Mokpo City, Heuksan Gun) belonging to the west sea area of Jeonnam province.

The data of boat number, tonnage and KW were collected by Fisheries Statistical Yearbooks and each provincial fisheries data similarly landing data. In the case of Jeonnam province, they were estimated using the two local provincial governments (Mokpo City, Heuksan Gun) belonging to the west sea area of Jeonnam province.

The total landing rate of commercially important species in ROK by year were collected from Fisheries Statistical Yearbooks and each provincial fisheries data, but, in the case of Jeonnam province, it was estimated using the landing rate data from the two local provincial governments (Mokpo City, Heuksan Gun) belonging to the west sea area of Jeonnam province.

We also adopted the data and information of growth parameters and spawning characteristics by species using the websites, the established research results of National Fisheries Research and Development Institute and three universities.

Data and information of fisheries are easy to get through accessing MOMAF website. However, data or information on total landing and fishing efforts are difficult to get from websites or related institutions.

Although some information on the annual fishing effort data by region are shown in the Fisheries Statistical Yearbooks and a related website, the fishing effort by fisheries, CPUE, biological and ecological data are not shown in any Yearbooks and websites.

So, to solve these problems, we visited related Provincial Government, universities and research institutes focusing on the Yellow Sea, and asked or investigated all accessible information.

The data of species composition, seasonal distribution density by dominant species and ichthyoplankton distribution characteristics in spring by trawl survey were collected and analyzed in survey results performed by West Sea Fisheries Research Institute in May (Table 11~13).

Based on the collected data and information, long term trends of landings of total and by commercially important species and fishing efforts, recently seasonal species composition and distribution density by dominant species and ichtyoplankton were described, and then reviewed fisheries resources conditions in the Yellow sea.

2.2 Socio-economic

Statistical data and information were collected by searching various governmental websites such as the National Statistical Office, the Ministry of Maritime Affairs and Fisheries (Refer Section VIII, Fig. 11).

The numbers of fishing boats were referenced from annual reports on fisheries trend written by the Ministry of Maritime Affairs and Fisheries. The numbers of regional fishing boats were referenced from ”Basic Statically Research in Korean Fisheries” written by the National Statistical Office. Fisheries Income were taken from ”The Static on Fishing Household Economy” written by National Tax Service and Fisheries Income were calculated by subtracting Fishery Production Expense from Gross Fishery Receipts.

The Fishery consumption per capita were assumed by calculating one year assumption by Kg and the data were derived from 「The Table about demand and supply of Korean Food」 written by Korea Rural Economic Institute.

Fishery export and import data were referenced from 2004 annual report by Korea Customs Service and sorted by the order of countries that had the largest quantity and the measurement were in terms of US $1000.

The data of imports and exports were referenced from Korea Customs Service and the report was organized in the order of kind of fishes that had the largest import and export volume.

In economic importance of fisheries, GDP Contribution was assumed by calculating level of contribution of whole GDP versus fisheries using economy statistic system of The Bank of Korea.

Based on the data and information, recent trends were reviewed by items such as numbers of fishing boats, fisheries income, fishery consumption per capita, fishery exports and imports, and economic importance of fisheries.

2.3 Mariculture

We visited a total of 11 institutions including five provincial governments, five Regional Maritime & Fisheries Offices, and interviewed responsible persons in charge and collected data. And also we visit websites related to aquaculture and statistics (Refer Section VIII, Fig. 11).

Data and information of aquaculture production are easy to access in websites or MOMAF. Reliable data or information on licenses (number of farms) and area of marine farms, however, are not easy to access from websites or related institutions. Although some information on licenses and area of aquaculture farms are shown in websites of MOMAF or Bureau of Statistics, these are mentioning total statistical figures of whole country only and don't classify into different provinces. Moreover, most information on farmed area and aquaculture methods is restricted to last two or three years.

To solve these problems, we visited all Regional Marine Affairs & Fisheries Offices and Provincial Governments bordering the Yellow Sea area and collected all accessible information of last 10 years. To collect these information on Jeonnam province, we had to visit five local provincial governments ("Gun Government") belonging to the west sea area of Jeonnam province (Refer Section VIII, Fig. 11).

3 DATA ANALYSIS AND REVIEW

3.1 Fisheries

3.1.1 Landing trends of the total and by species

The mean total landings of 10 commercially important species from 1986 to 2004 in the West Sea of ROK were shown in the order of anchovy (*Engraulis japonicus*), largehead hairtail (*Trichiurus lepturus*), acetes (*Acetes chinensis* and *A. japonicus*), squids (*Todarodes pacificus*, *Loligo* sp. and *Sepia* sp.), small yellow croaker (*Larimichthys polyactis*), chub mackerel (*Scomber japonicus*), sandlance (*Ammodytes personatus*), Spanish mackerel (*Scomberomorus niphonius*), fleshy prawn (*Fenneropenaeus chinensis*) and Pacific herring (*Clupea pallasii*) (Table 6).

The total landing has been largely decreased since 1987 from 141,992 t to about 63,102 t in 2003, the volume in 2003 was less than a half of it in the mid 1980s (Table 6).

The annual landings of almost commercially important species largely showed gradually decreased trends from early 1990s except anchovy. The landing of anchovy that had the highest level of the species mean annual landings showed the range of 20,000~30,000 t during 1986~1992, and after that it was increased to the level of 46,000 t during 2000~2004. On the contrary, largehead hairtail had the second level of the mean species annual landings showed about 50,000 t during 1986~1991, and then it was dramatically decreased to about 6,000 t during 2000~2004 (Fig. 1, Table 6).

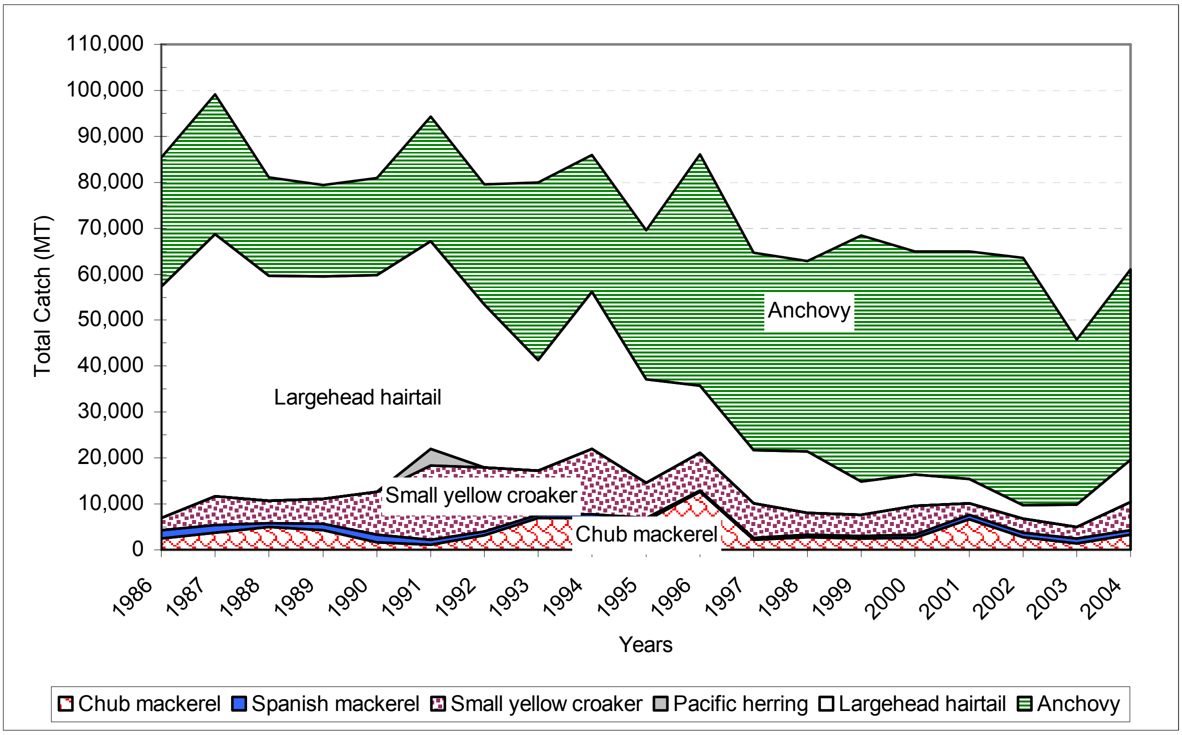
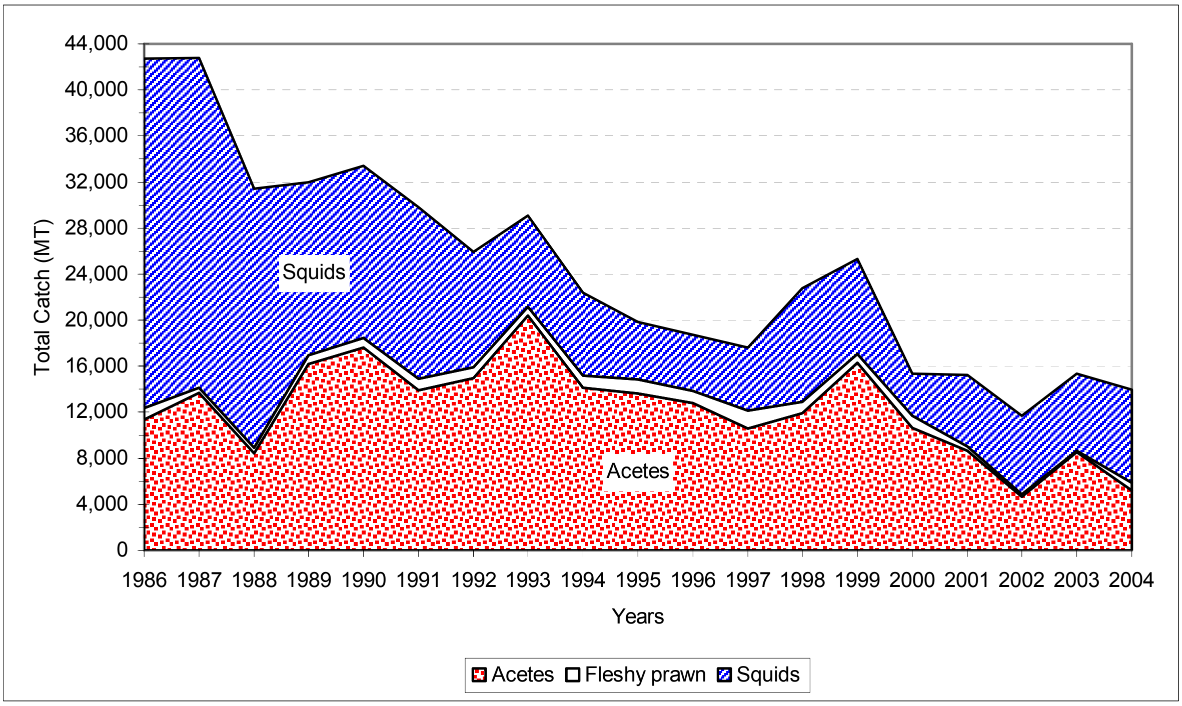


Figure 1. Landing trends of commercially important species in the Yellow Sea, 1986~2004.



.Figure 2. Landing trends of commercially important species in the Yellow Sea, 1986~2004 (Con't)

3.1.2 Trends of fishing efforts

In this repot Number, Tonnage and KW of fishing vessels were considered based on the collect data and information to understand trends of the fishing efforts in Korean fisheries in correspondence to the Yellow Sea.

- Number of fishing boats

  The number of non-powered fishing boats decreased from 7,464 in 1988 to 1384 in 2004. On the other hand the numbers of powered fishing vessels were maintained at about 26,000 from 1986 to 1998, and after that it showed an increasing trend as about 32,000 from 1999 to 2004 (Fig. 2, Table 7). The total number of fishing boats showed a slightly increased trend from 24,621 in 1997 to 33,939 in 2004 (Fig. 2, Table 7).

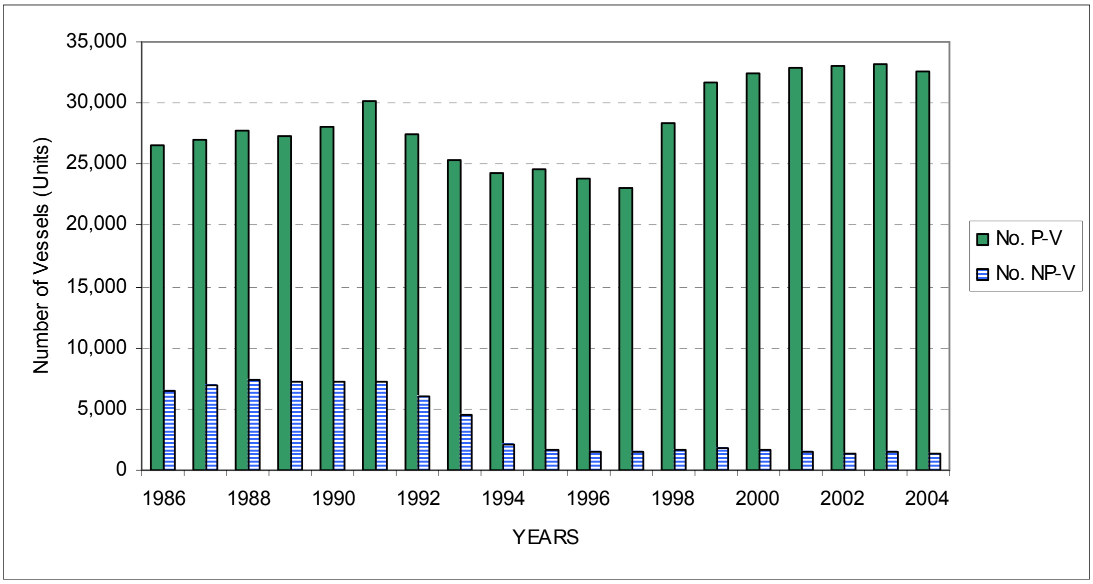


Figure 3. Trends of number of powered and non-powered fishing vessels

- Tonnage of the fishing boats

  The gross tonnage of the total fishing boats appeared a decreased trend from 173,226 in 1988 to 132,305 in 2004 (Table 7). The gross tonnages per boat of two kinds of fishing boats have been decreased since 1994, and in 2004 those were 4.03 and 0.82 for powered and non-powered fishing boats, respectively, and the total gross tonnages of both fishing boats have decreased since 1994 (Figs. 3, 4, Table 7).

- KW of the fishing boats

  However, the power in KW (multiple HP by 0.753) of the fishing boats presents a sharply increasing trend from about 648, 000 in 1986 to 4,012,000 in 2004 (Fig. 3, Table 7).

  According to the above results it was considered that the size of fishing boats became smaller, but the power stronger. That means fishing intensity has been increased even though the number of fishing boats has been maintained stably. The rapid increased trend of KW of the fishing boats might be caused by the improvement of fishing equipments and boat efficiency.

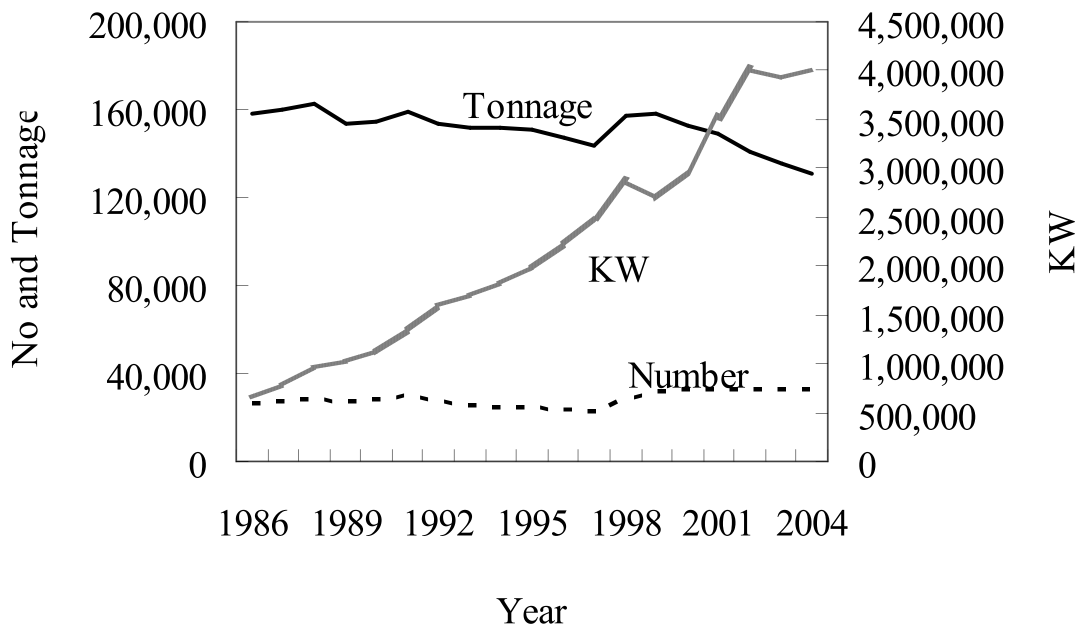


Figure 4. Variations of tonnage, KW and number of powered fishing vessels 1986~2004.

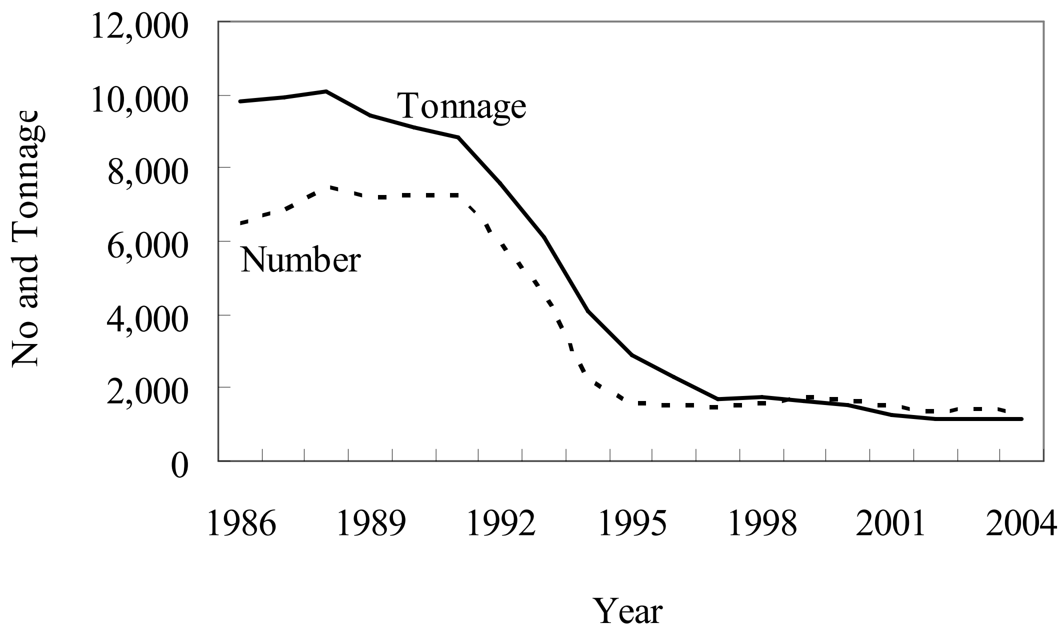


Figure 5. Variations of tonnage and number of non-powered fishing vessels 1986~2004

- Landings of non-powered and powered fishing boats

  The landing of non-powered fishing boats decreased to the very low level, and that of powered fishing boats has been decreased since 1998. The volume of the powered boats was about 130,000 t in 2004 (Fig. 5).

  Based on the results, it is revealed that total mount of landing by South Korean fishermen from the Yellow Sea has been decreased since late of 1990s.

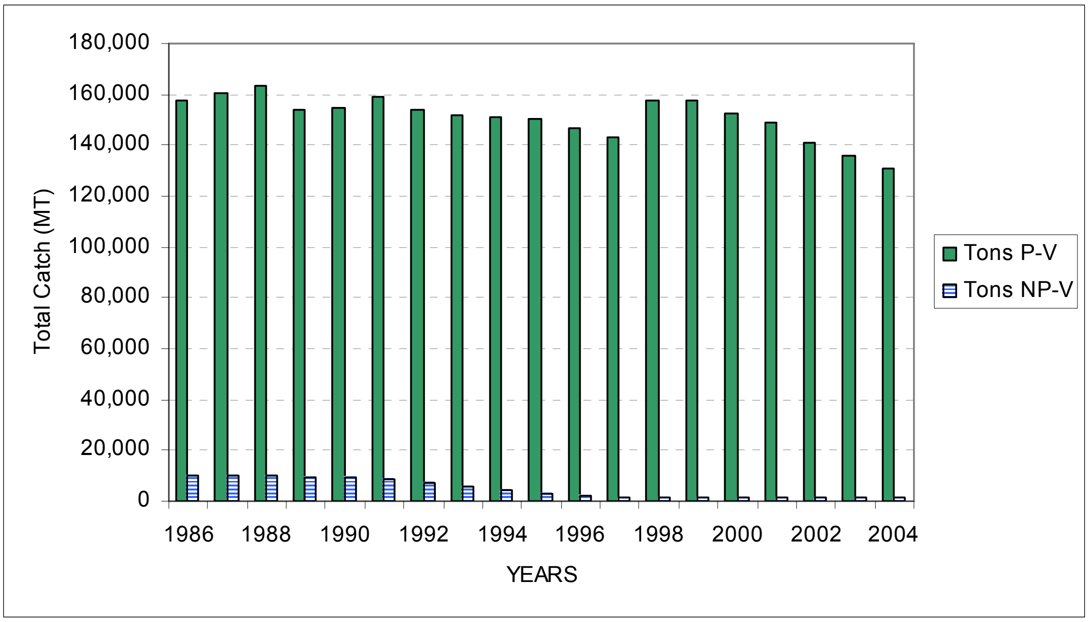


Figure 6. Trends of total landings of powered and non-powered vessels

3.1.3 Changes of species composition in landings

In landing ratio of commercially important 10 species to the total landing off the Yellow Sea, largehead hairtail showed the most dominant species with the highest ratio as 11~13% during 1986~1992, fleshy prawn and Spanish mackerel showed the lowest ratio as 0.3%. The dominant ratio of commercially important 10 species to the total landing off the Yellow Sea was about 32% in average, and it showed a stable level during 1986 through 2004 (Table 8).

Decadal changes of 10 commercially important species composition

In the species composition of 10 commercially important species' landings, largehead hairtail was the most dominant species, representing 41.5% of the total landing of the 10 species in 1980s, and followed by anchovy 20.1%, squids 19.4%, acetes 10.1%, small yellow croaker 3.8%, chub mackerel 3.2%, Spanish mackerel 1.2%, and fleshy prawn 0.5% orderly (Fig. 6).

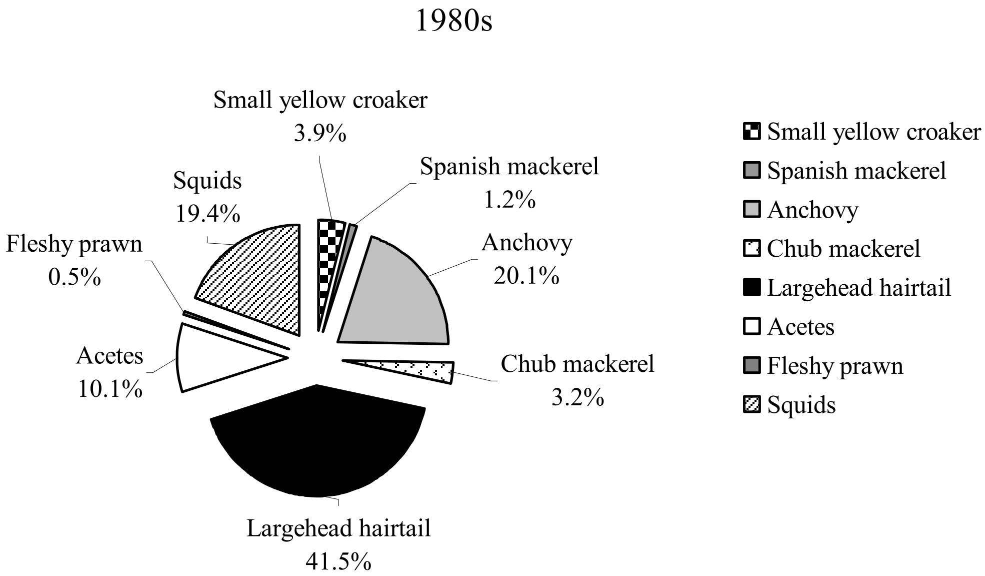


Figure 7. Species composition of 10 commercially important species landing off the Yellow Sea in 1980's.

In 1990s, anchovy was the most dominant species with 37.5% in the 10 species' total landing, and next largehead hairtail 23.8%, acetes 14.4%, small yellow croaker 9.2%, squids 8.5%, chub mackerel 4.7%, fleshy prawn 1.0%, Spanish mackerel 0.7% orderly (Fig. 7).

In 2000s, anchovy was also the most dominant species showing 61.6% of the 10 species' total landing, and then acetes 10.0%, squids 8.6%, largehead hairtail 7.9%, small yellow croaker 5.5%, chub mackerel 4.6%, Spanish mackerel 1.3%, fleshy prawn 0.7% in sequence (Fig. 8).

In the overall tendency of species composition from 1980s to 2000s, the landing ratio of largehead hairtail, which was the largest occupancy in 1980s, has decreased gradually since 1990s. On the other hand, the landing ratio of anchovy was the largest occupancy during 1990s through 2000s.

That means the landing composition has been changed from the large and demersal fishes to the small and pelagic fishes.

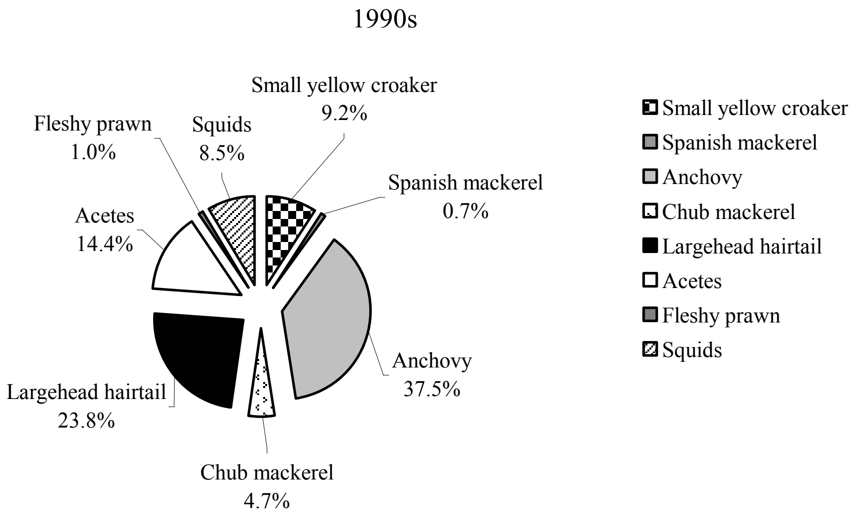


Figure 8. Species composition of 10 commercially important species landing off the Yellow Sea in 1990's.

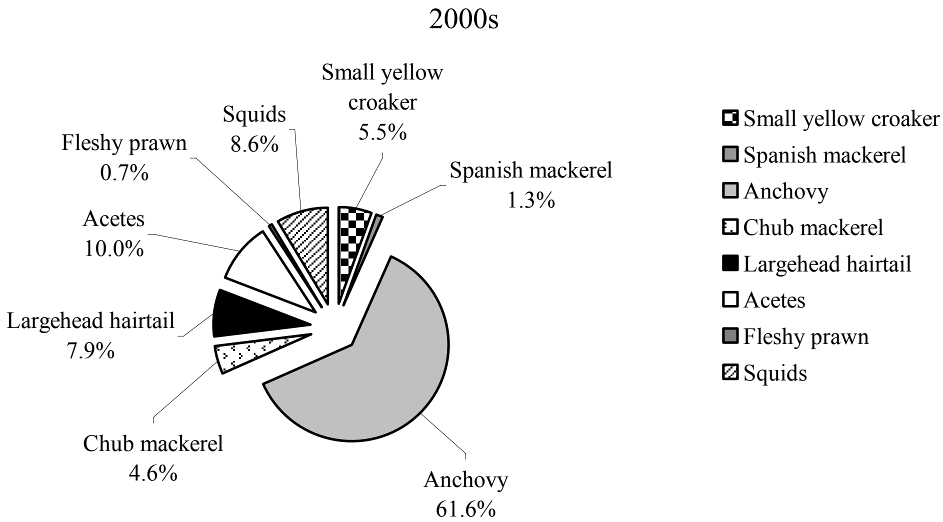


Figure 9. Species composition of 10 commercially important species landing off the Yellow Sea in 2000's.

3.1.4 Survey results by bottom trawl

The annual and seasonal changes of the species composition and distribution density of the dominant species were revealed based on the catches by the bottom trawl conducted in the month of May from 2003 to 2005 in the Korean side of the Yellow Sea by Korean West Sea Fisheries Research Institute, NFRDI's research vessels.

- Annual species composition

Lateolabrax japonicus was the most dominant species representing 29.1% of the total catch in 2003. *Lophius litulon* was the most abundant species comprising 32.4% and 23.7% of the catches in 2004 and 2005, respectively (Table 9).

- Seasonal species composition

In 2003, *Lophius litulon* was the most dominant species showing 17.3% of the total catch in spring. It was followed by *Hemitripterius villosus* (16.6%), *Zoarces gilli* (8.0%), *Gadus macrocephalus* (6.9%), and other species (less than 5%) orderly. On the other hand, *Lateolabrax japonicus* was the most dominant species comprising 38.7% of the total catch in the winter season. It was followed by *Sebastes schlegeli* (21.8%), *Loligo beka* (9.8%), *Liparis tanakai* (3.6%), and other species (less than 3%) consequently. Three species, *L. japonicus, S. schlegel* and *L. beak,* were constituted approximately 70% of the total catch (Table 9).

In 2004, *Lophius litulon* was the most dominant species comprising 37.6% and 28.9% of the total catches in spring and winter seasons, respectively. In spring, the second dominant species was *Hemitripterius villosus* with 10.6%. It was followed by *Hexagrammos otakii* (4.9%), *Cragon affinis* (4.9%), *Squalus megalops* (4.3%), and other species (less than 4%) in order. These above five species were constituted more than 60% of the total catch. In the winter season *Collichthys niveatus* was the second dominant species comprising 11.8%. It was followed by *Liparis tanakai* (9.9%), *Loligo beka* (7.3%), *Sebastes schlegeli* (5.7%), and other species (less than 5%) consequently (Table 9).

In 2005, *Lophius litulon* was also the most dominant species with 18.4% and 31.6% of the total catches in spring and winter seasons, respectively. *Cragon affinis* was ranked as the second dominant species in both seasons showing 14.4% in the spring and 7.2% in the winter catches. In spring season, the third dominant species was *Sebastes schlegeli* comprising 7.2% . It was followed by *Gadus macrocephalus* (6.6%), *Squalus megalops* (5.8%), *Ammodytes personatus* (5.1%), and other species (less than 5%) orderly. In winter season, *Paralichthys olivaceus* was ranked as the third dominant species representing 6.7%. It was followed by *Loligo beka* (6.0%), *Collichthys niveatus* (5.4%), *Oregonia gracilis* (5.3%), and other species (less than 5%) consequently (Table 9).

- Seasonal distribution density of dominant species

In 2003, *Lateolabrax japonicus* occurred at only one station in the winter season. The annual mean density of the species in the study area was 226.4㎏/㎢, the highest density. The annual mean density of *Sebastes schelegeli* was 133.3 ㎏/㎢ and ranged from 4.6 to 2,603.3㎏/㎢. *Loligo beka* appeared at 6 stations, and the mean densities were 2.9 and 114.6㎏/㎢ in spring and winter seasons, respectively. The species which showed the highest mean density among the crustaceans was *Oregonia garacilis* with 23.8 ㎏/㎢ annual mean density. It showed a wide distributed area appearing at more than 8 stations in spring and winter seasons, respectively. According to the species appeared at more than 8 stations in the both seasons, it was considered that the distributional area of the species is relatively wide. *Lophius litulon* and *Hemitripterus villosus* showed high annual mean densities, 47.9 and 42.1㎏/㎢, respectively. *Liparis tanakai* and *Gadus macrocephalus* are dominant cold water species in the Yellow Sea. These species showed comparatively high annual mean densities, 22.8 and 16.5 ㎏/㎢, respectively. *Liparis tanakai* showed comparatively high mean density, 42.3 ㎏/㎢, in winter, but *Gadus macrocephalus* showed it, 26.3㎏/㎢, in spring season (Table 10).

In 2004, *Lophius litulon* showed the highest annual mean density, 157.3 ㎏/㎢, ranged from 8.7 to 694.8 ㎏/㎢ and the widest distribution area. Its seasonal distribution density was not different much between spring and winter. The annual mean density of *Collichthys niveatus* was 36.0 ㎏/㎢ (ranged 0.5~997.8 ㎏/㎢). Its seasonal distribution density (65.3 ㎏/㎢) in winter was higher than it (3.1㎏/㎢) in spring season. It was followed by *Sebastes schelegeli* representing the annual mean density of 32.2 ㎏/㎢, ranged 1.1~515.4 ㎏/㎢. The annual mean density of *Hemitripterus villosus* was 30.6 ㎏/㎢ and the mean density (43.9㎏/㎢) in spring season was higher than two times of that in winter season. The annual mean densities of *Liparis tanakai* and *Loligo beka* were 30.0㎏/㎢ and 28.7㎏/㎢, respectively. The seasonal distribution densities of two species were higher in winter season. *Cragon affinis* was the species that showing the highest annual mean density (21.3 ㎏/㎢) among the crustaceans. It was widely distributed in two seasons, and the seasonal difference of densities was insignificant. *Oregonia gracilis* was also one of the widely distributed crustacean species, and it's annual mean density (21.3 ㎏/㎢) was comparatively high. *Hexagrammos otakii* and *Cleisthenes pinetorum* were high ranked species showing high abundant (Table 10).

In 2005, *Lophius litulon* was the most abundant species. Its annual mean density was 134㎏/㎢, ranged from 3.7 to 988.1㎏/㎢. Its mean density in winter was slightly higher than it in spring. *Cragon affinis* ranked second in the annual mean densities, which was 65.1㎏/㎢. It was caught at the all stations in two seasons. The annual mean density of *Collichthys niveatus* was 28.9㎏/㎢. This species was more widely distributed in winter than in spring, but its mean density in winter season was lower than that in spring season. The distribution area of *Gadus macrocephalus* was restricted in the cold water mass, and this species was caught at 8 and 6 stations in spring and winter, respectively. Its annual mean density was 27.5㎏/㎢, ranged from 2.1㎏/㎢ to 198.6㎏/㎢. *Oregonia gracilis* showed the annual mean density of 26.3 ㎏/㎢ similar to those in 2003 and 2004. *Sebastes schlegeli, Loligo beka and Hemitripterus villosus* showed comparatively high annual mean densities, 24.7, 21.3 and 20.3㎏/㎢, respectively. *Aqualus brevirostris* was caught at only two stations in spring season and its annual mean density was 19.6 ㎏/㎢. *Ammodytes personatus* showed the annual mean density of 18.9㎏/㎢, ranged from 1.2 to 642.1㎏/㎢. Its density in spring season was considerably higher than that in winter season (Table 10).

- Distributional density of fish larvae and eggs

The distributional density of fish larvae and eggs was revealed based on the results of the ichthyoplankton surveys carried out using Korean West Sea Fisheries Research Institute, NFRDI's research vessels in Korean side in the Yellow Sea in the month of May, 2003~2005.

In 2003, 3 species of fish larvae and 1 species of fish eggs were identified. *Sebastes schelegeli* showed the mean density, 4.6 inds/1,000㎥ ranged 4.9~24.0 inds/1,000㎥ at 3 stations. *Engraulis japonicus* caught at only 1 station and its density was 7.5 inds/1,000㎥. Unidentified fish eggs showed the mean density 112.3 inds/1,000㎥ (Table 11).

In 2004, 2 species of fish larvae, *Cleisthenes pinetorum herzensteini* and *Sebastes schelegeli* were identified. The mean densities of these species were very low as 0.1 and 0.4 inds/1,000㎥, respectively. Eggs of *Engraulis japonicus* showed the mean density, 0.6 inds/1,000㎥ ranged 0.9~12.0 inds/1,000㎥ at 4 stations (Table 11).

In 2005, 6 species of fish larvae were identified. Among them, *Engraulis japonicus* showed the highest mean density, as 4.9 inds/1,000㎥ ranged 9.9~37.0 inds/1,000㎥ at 3 stations. *Sebastes schelegeli* caught at 6 stations, so it could be considered that this species was the most widely distributed one in the Korean West Sea in May. *Sebastes vulpes, Liparis* sp., *Limanda herzenstein* and *Lophius litulon* caught separately at only 1 station. Each species' distributional density was very low, less than 1 inds/1,000㎥. The mean density of eggs of *Engraulis japonicus* was 3.8 inds/1,000㎥ ranged 62.7~78.6 inds/1,000㎥ at 3 stations (Table 11).

3.1.5 Growth parameters for commercially important 10 species

The growth parameters including theoretical maximum length (L_∞), growth coefficient (K), theoretical age at length equal 0 (t_0), length-weight relationship ($W=aL^b$) and longevity for 10 commercially important species were shown in Table 12. Some of the parameters are published and some of them are not.

- Small yellow croaker

In the case of small yellow croaker, the growth parameters were estimated as follows: L_∞ was 34.7~36.2cm, K was 0.332~0.376, t_0 was -0.609~-0.593 year, length-weight relationships were 0.004298 $TL^{3.227}$ or 0.0196 $TL^{2.802}$ and longevity was 10 years (Hwang and Choi, 1980; NFRDI, 2005).

- Spanish mackerel

The growth parameters of Spanish mackerel were estimated as follows: the theoretical maximum length (L_∞) was 123.3cm, growth coefficient (K) was 0.196, theoretical age at length equal 0 (t_0) was -2.140 year, length-weight relationship ($W=aL^b$) was 6.577x10^6 $FL^{3.002}$ and longevity was 8 years (NFRDI, 2005).

- Chub mackerel

The growth parameters of chub mackerel were estimated as follows: the theoretical maximum length (L_∞) was 40.2~51.7cm, growth coefficient (K) was 0.299~0.408, theoretical age at length equal 0 (t_0) was -0.719~0.428 year, length-weight relationship ($W=aL^b$) was 1.756x10^6 $FL^{3.342}$ or 0.00044 $FL^{3.332}$ or 0.0056 $FL^{3.2537}$ and longevity was 6 years (Ahn, 1971, Choi et al., 2000; NFRDI, 2005).

- Largehead hairtail

The growth parameters of largehead hairtail were estimated as follows: the theoretical maximum length (L_∞) was 45.6~52.3cm, growth coefficient (K) was 0.154~0.408, theoretical age at length equal 0 (t_0) was -1.722~0.440 year, length-weight relationship ($W=aL^b$) was 0.06321 $AL^{2.5456}$ or 0.0323 $AL^{2.7826}$ and longevity was 9 years (Park et al., 1996, 2000; NFRDI, 2005).

3.1.6 Biological data

The reproduction and spawning characteristics including fecundity, optimum temperature (℃), 50% maturity length and spawning season of commercially important 10 species were shown in Table 13.

- Small yellow croaker

The reproduction and spawning characteristics of small yellow croaker were estimated as follows: the fecundity was 3~10x10,000 individuals, optimum spawning temperature was 12~14℃, minimum length at maturity was 19.1cm and spawning season was April ~ June (NFRDI, 2005).

- Spanish mackerel

The reproduction and spawning characteristics of Spanish mackerel were estimated as follows: the fecundity was 50~90x10,000 individuals, optimum spawning temperature was 16~21℃, minimum length at maturity was 78cm and spawning season was April ~ August (Hwang et al., 1977; NFRDI, 2005).

- Anchovy

The reproduction and spawning characteristics of anchovy were estimated as follows: the fecundity was 2.3~31.5x10,000 individuals, optimum spawning temperature was 15~20℃ and spawning season was March ~ October (Lim et al., 1970; Choi and Kim, 1988; Cha, 1990; Kim and Kang, 1992).

- Chub mackerel

The reproduction and spawning characteristics of chub mackerel were estimated as follows: the fecundity was 11~140x10,000 individuals, optimum spawning temperature was 17~18℃, minimum length at maturity was 27.0~28.7cm (fork length) and spawning season was January ~ June (Cha et al., 2002; NFRDI, 2005).

- Largehead hairtail

The reproduction and spawning characteristics of largehead hairtail were estimated as follows: the fecundity was 2~8.5x10,000 individuals, optimum spawning temperature was 18~20℃, minimum length at maturity was 25.7cm (anal length) and spawning season was May~August (NFRDI, 2005).

3.1.7 Seasonal distribution and migration routes of 10 commercially important species in the Yellow Sea

Most of commercially important species except some species inhabit the cold water mass and coastal sedentary species in the Yellow Sea have seasonal migration patterns between the East China and Yellow seas. They usually hibernate in the bordering area, where is affected by the Kuroshio Current, between the East China and Yellow seas, migrate to Korean or Chinese coastal areas for spawning and nursery in spring and go back to the wintering area in autumn (NFRDI, 2005).

- Largehead hairtail, *Trichiurus lepturus*

The species distributed in the Yellow Sea can be divided into two subpopulations according to wintering areas and migration routes; one called as the Northern East China Sea population spends winter in the northern part of the East China Sea as the name shows, and the other one called as the Yellow Sea population overwinters in the west-southern area of Jeju Island adjacent water, and both subpopulations migrate to coasts in the Yellow Sea and East China Sea in spring to spawn and nursery from May to August, and then come back to the wintering grounds in the fall (Fig. 9).

- Chub mackerel, *Scomber japonicus*

Chub mackerel has a wide migration route in the Yellow Sea. The species in the Yellow Sea can be largely divided into two subpopulations based on their wintering grounds and migration routes; one called as the East China Sea population stays over winter in the northern part of the East China Sea, and the other one called as Jeju Island offshore population overwiners in the south-eastern area of Jeju Island offshore. In spring they migrate up to the mid-part of the Yellow Sea and swim back to the wintering and spawning grounds in the autumn. They spawn from March to April in the East China Sea, and from April to May in the Jeju Island (Fig. 10).

- Fleshy prawm, *Fenneropenaeus chinensis*

This species distributes mainly in sandy or muddy bottoms in the Yellow Sea and Bohai Sea. The shrimp population can be divided into two subpopulations based on their breeding areas and migration routes. One is the western coast of the Yellow Sea population, which hatched in the coast of the Bohai Sea and the Yellow Sea. The other is the eastern coast of the Yellow Sea population, which hatched in the Korean western coast. In spring the Korean stock starts to migrate from the southern part of the Yellow Sea, their wintering ground, to Korean western coast, spawns mainly in the coast of Chungcheongnam Province from April to June, and then die. In autumn the new recruits migrate to the wintering ground (Fig. 11).

- Anchovy, *Engraulis japonicus*

This species is a small pelagic species distributed widely in the Yellow Sea, East China Sea and East / Japan Sea. The Yellow Sea population seasonally migrates according to changes of surface water temperature; in spring it migrates to the coastal area along the Korean Peninsula, spawns mainly in the mouth of Keum River from June to August, and in autumn migrates back to the wintering ground in the southern part of the Yellow Sea (Fig. 12).

- Pacific squid, *Todarodes pacificus*

Pacific squid in Korean adjacent waters are divided into three stocks based on their birth seasons; one of them is called as a stock hatched in autumn from October to December, the second one hatched in winter from December to March, and the third one hatched in spring from May to August. Their spawning grounds seemed in the East / Japan Sea or East China Sea, but not identified exactly because of the lack of information (Fig. 13).

- Spanish mackerel, *Scomberomorus niphonius*

The species stays near Jeju Island, where is affected by the warm current, during winter time, starts to swim to the coastal areas for spawning in spring, spawns in muddy bottoms in the relatively shallow coastal areas or in the bays in Korean coast from May to July, and then starts to migrate back to the wintering ground in autumn (Fig. 14).

- Small yellow croaker, *Larimichthys polyactis*

Small yellow croaker, spread widely in the Yellow Sea and East China Sea, can be divided into a number of subpopulations by the migration routes. One of them, which is called as Korean subpopulation, starts to approach to the Korean coast in spring, and migrates northward along the Korean western coast, and then spawns mainly near Chungcheongnam or Hwanghae provinces from April to June, after then migrates offshore and back to the wintering area (Fig. 15).

- Pacific herring, *Clupea pallasii*

This species is known as one of the cold water species and to be divided in two subpopulations in Korean waters; one is the East Sea subpopulation and the other is Yellow Sea subpopulation. The Yellow Sea stock inhabits the clod water mass all year round in the Yellow Sea. They usually migrate to the coasts (during winter time) and offshore (during summer time) as the changes of the season.

- Acetes, *Aectes chinensis* and *A. japonicus*

Those species are a kind of sedentary species. They migrate in and off shore as the change of season. They usually distribute mixed with the two species together along the west coast of Korea.

- Sandlance, *Ammodytes personatus*

This species is not known much in Korea, so it is difficult to mention about the migration of the species. It caught in coastal areas of Chungnam province and Baik-lyeong Island during a very shot period in spring.

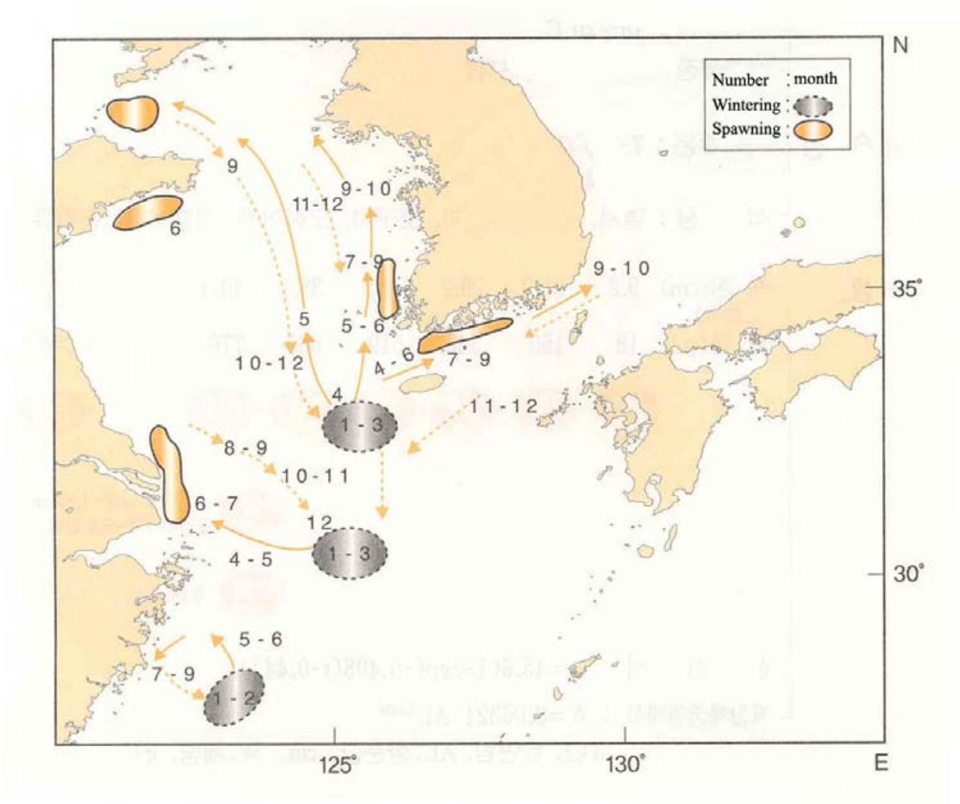


Figure 10. The wintering, spawning sites and migration routes of largehead hairtail (*Trichiurus lepturus*) in the Yellow Sea.

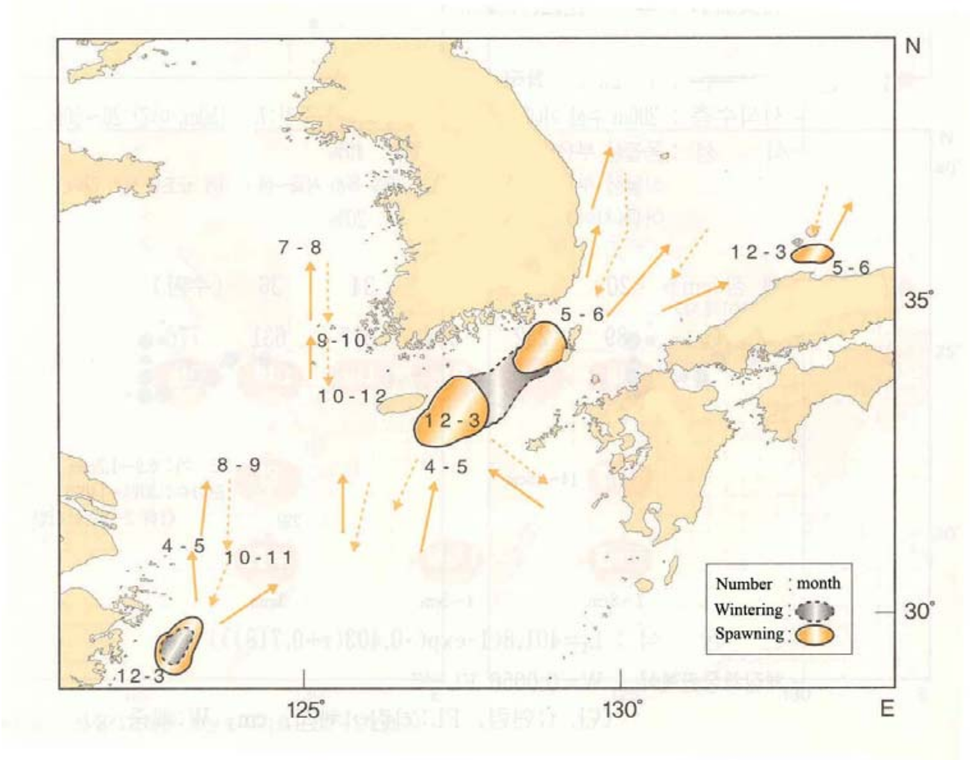


Figure 11. The wintering, spawning sites and migration routes of chub mackerel (*Scomber japonicus*) in the Yellow Sea.

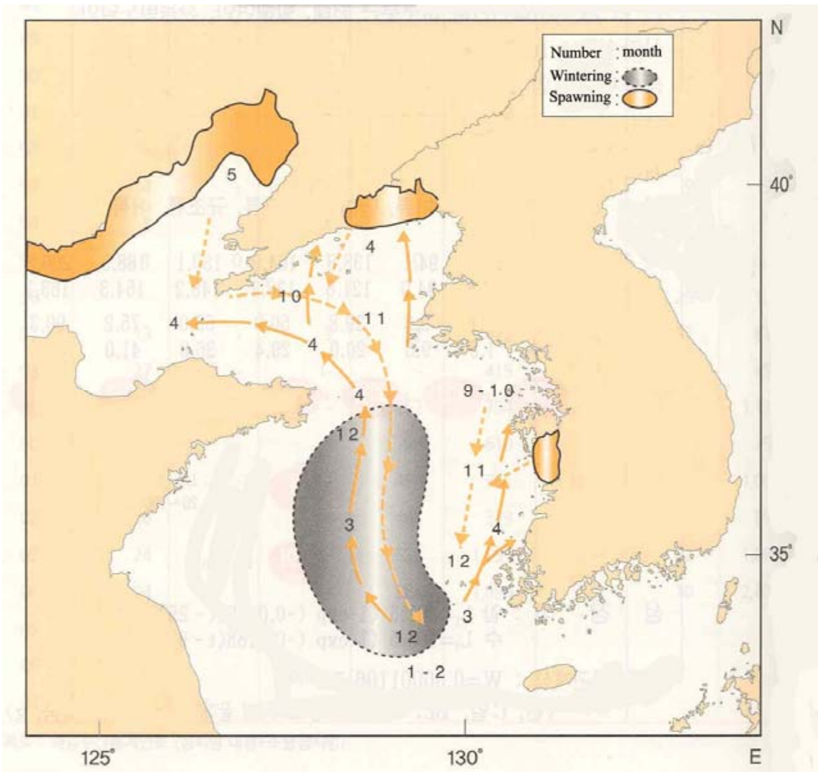


Figure 12. The wintering, spawning sites and migration routes of fleshy prawn (*Fenneropenaeus chinensis*) in the Yellow Sea.

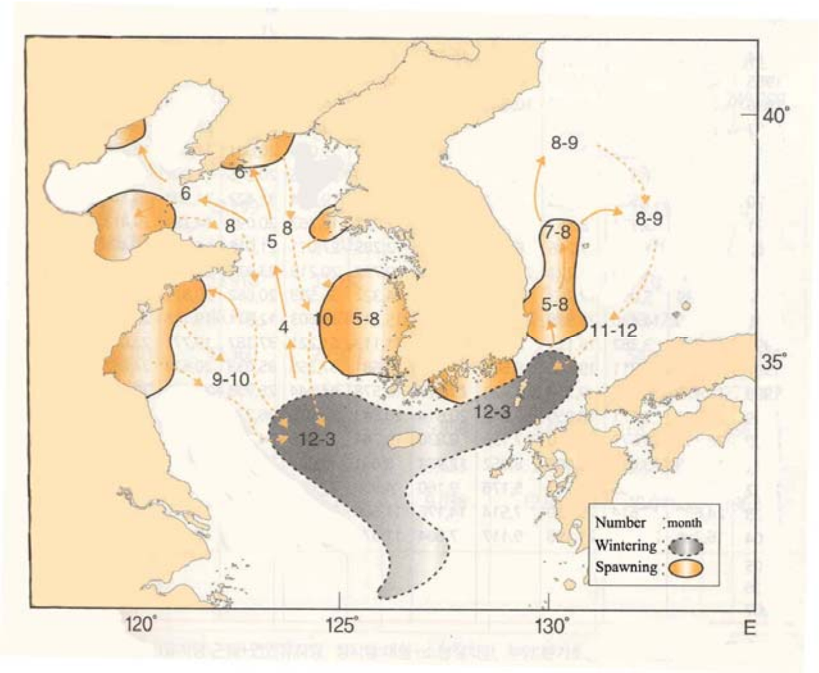


Figure 13. The wintering, spawning sites and migration routes of anchovy (*Engraulis japonicus*) in the Yellow Sea.

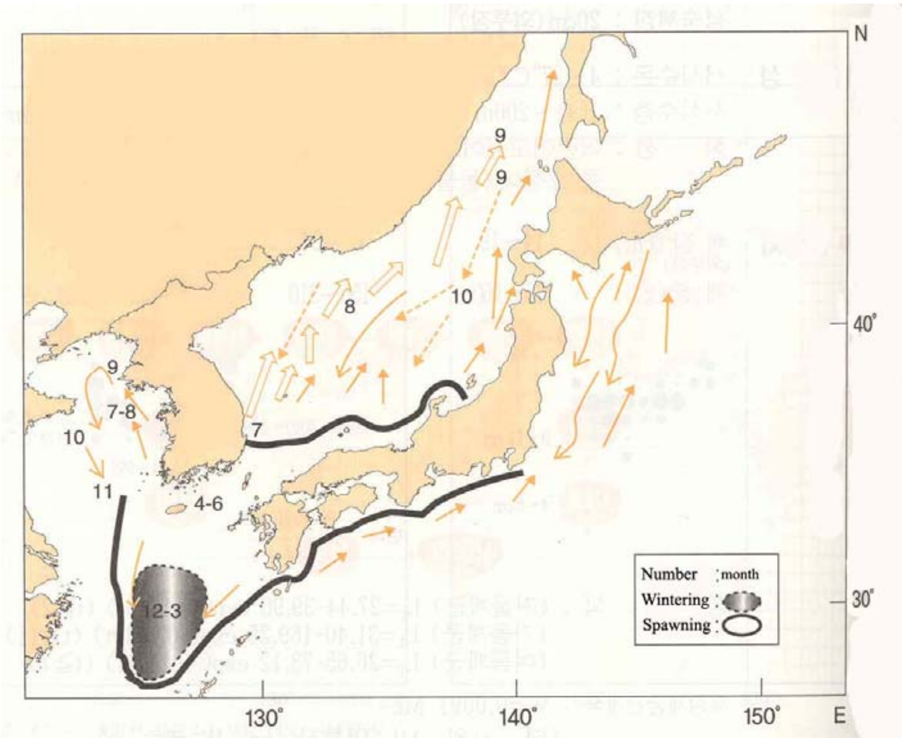


Figure 14. The wintering, spawning sites and migration routes of squid (*Todarodes pacificus*) in the Yellow Sea.

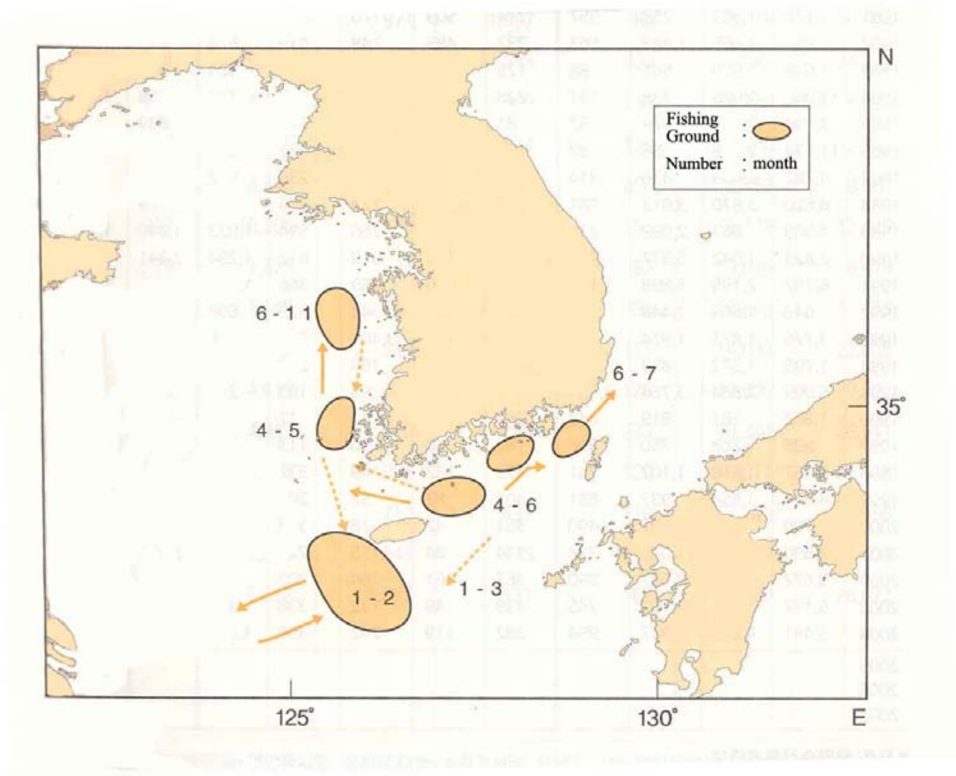


Figure 15. Fishing ground of Spanish mackerel (*Scomberomorus niphonius*) in the Yellow Sea.

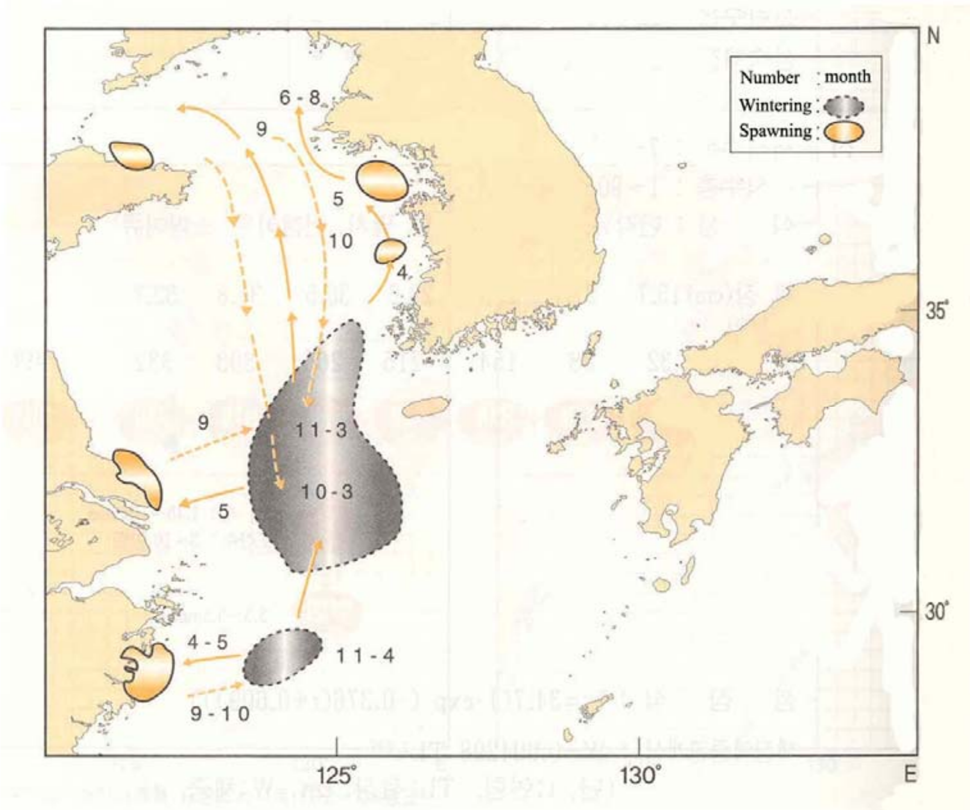


Figure 16. The wintering, spawning sites and migration routes of small yellow croaker (*Larimichthys polyactis*) in the Yellow Sea.

3.2 Socio-economics

To understand South Korean fishery socio-economic status, number and gross tonnage of fishing vessels, number of fishermen, fisheries income, fisheries consumption per capita, exports and imports of fishery products and economic importance of fisheries (GDP Contribution) are given.

3.2.1 Number and gross tonnage of fishing vessels by fishery

The number of distant waters fisheries vessels decreased about 28% from 20000 to 2004. Likewise, Gross tonnage (GT) of the fisheries decreased about 25% during the same period. The number and GT of Off-shore, Coastal Fisheries vessels decreased about 4% and 17%, respectively in 2004 compared to those in 2000 (Figs. 21 ~ 22, Table 14).

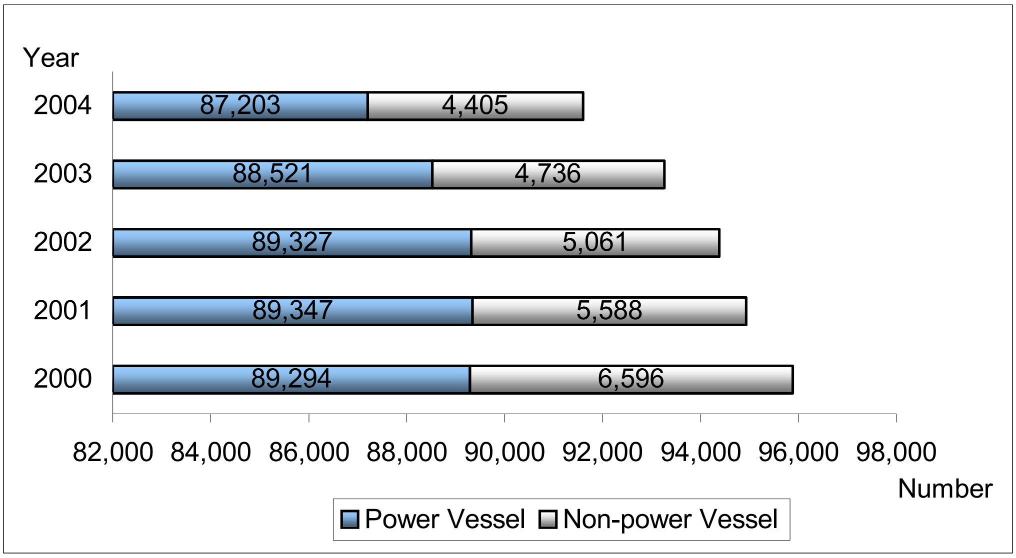


Figure 17. Number of fishing vessels by fishery.
Data source: Director General for Maritime Safety Management

Since 2000, the numbers of non powered and powered fishing vessels showed decreased tendencies. The total number of fishing vessels in South Korea decreased about 4.5% during 2000 through 2004 (Fig. 16, Table 14).

3.2.2 Number and gross tonnage of the fishing boats by province

The numbers of the fishing boats were relatively stable in the all of provinces from 2000 to 20004. GTs in Inchon, Jeonbuk and Jeonnam provinces decreased 16.7%, 39.5% and 11.2%, respectively during 2000 ~ 2004, but it in Gyeonggi and Chungnam provinces increased 35.1% and 13.0% during the same period. The highest number and GT of fishing boats appeared in Jeonnam Province as 36,095 boats and 101,646 GT (Figs. 23~24, Table 14).

3.2.3 Number of fishermen by province

Though the number of fishermen showed decreased trends in almost provinces, but in Gyeonggi Province it was sustainable. The highest number of fishermen appeared in Jeonnam Province (45 thousand individuals in 2004).

As a regional comparison, Incheon City number of fishermen decreased sharply in 40% while in Jeonnam Province it was gradually at 14% from 2000 to 2004, which ranked the first and second levels in decreasing trend (Table 16).

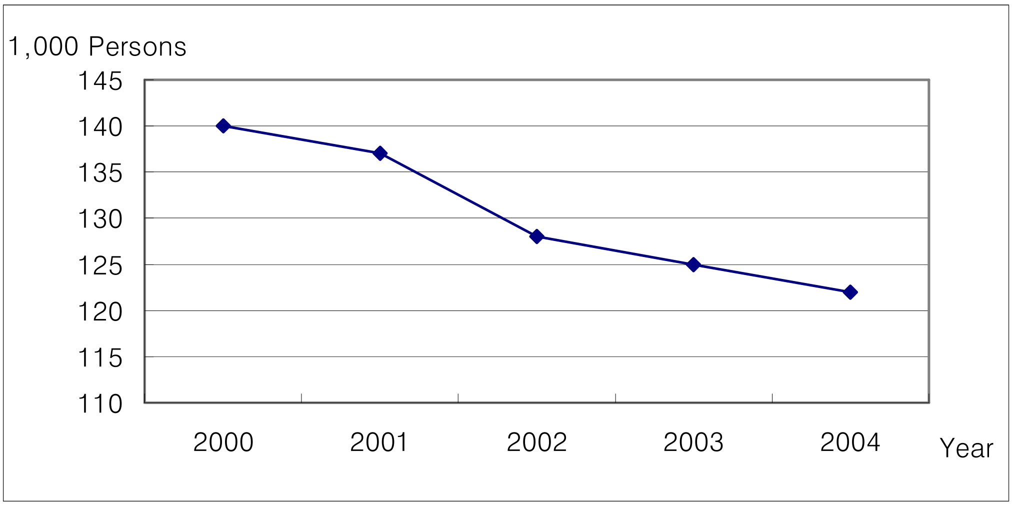


Figure 18. Number of fishermen.

Data source: National Statistical Office, 「Basic Statistical Research in Korean Fisheries」

For last 5 years, the total number of fishermen decreased about 12.9% from 140,000 in 2000 to 122,000 in 2004 (Fig. 18, Table 17).

3.2.4 Fisheries Income

According to the Customs Service the data, South Korean fisheries income was considered, it has been measured based on the unit of 1000won. From 2000 to 2004, fisheries income slightly increased about 18.6% showing annual variations (Table 17).

3.2.5 Fisheries consumption per capita (kg)

The consumption of marine product per person in South Korea has been measured in kg annually. From the year of 2000 to 2003, it increased about 21.4% from 36.8kg to 44.7kg (Table 18).

3.2.6 Exports and imports of fishery products

The total exports of fishery products continuously decreased about 15% from 1,504 millions in US $ in 2000 to 1,279 millions $ in 2004. However, imports of fishery products increased continually about 60.3% from 1,411 millions $ in 2004 to 2,261 millions $ in 2000 (Fig. 18, Table 19).

The exports of marine product decreased, but imports increased over the last 5 years. After the open market for marine products in ROK, the import volumes increased dramatically and this is expected to be continued (Fig. 18).

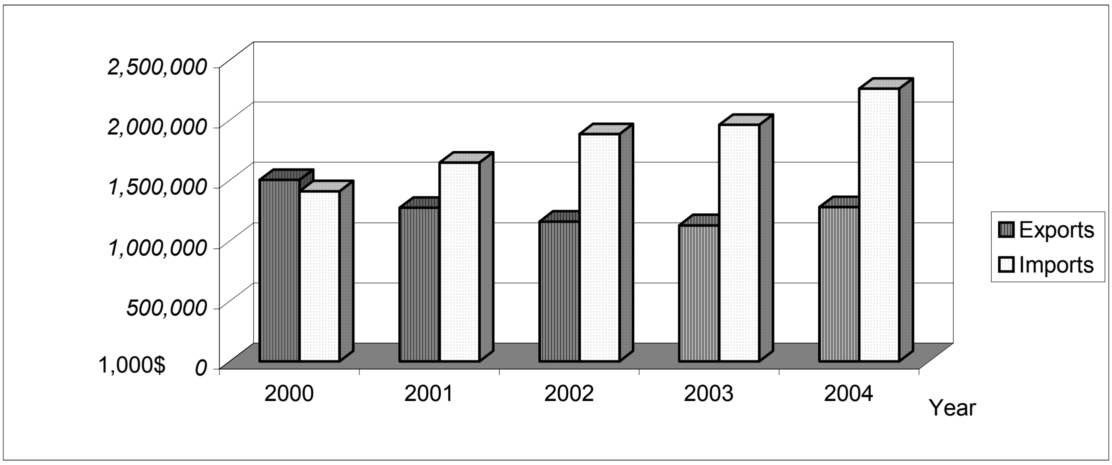


Figure 19. Imports and exports of fishery products
Data source: Korea Customs Service.

3.2.7 Economic importance of fisheries (GDP Contribution)

The ROK Gross Domestic Product (GDP) has been increased over the last 5 years. However, the Figure of GDP for fisheries was on the decrease slope by steps, its contribution showed a tendency to be decreased gradually (Fig. 20).

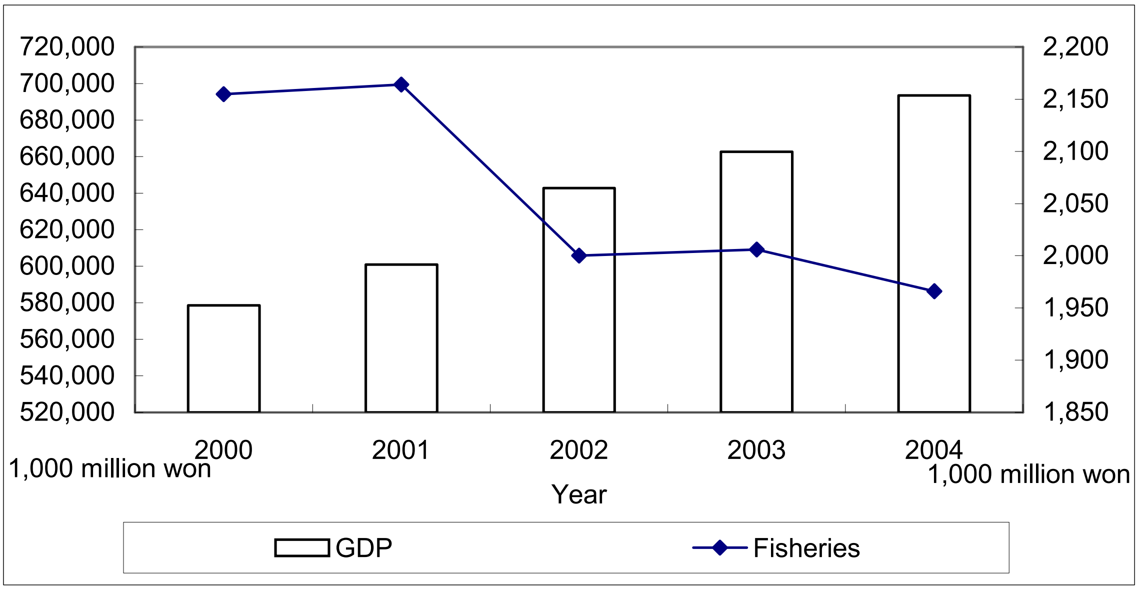


Figure 20. Gross domestic product (GDP) and fisheries.
Data source: The Bank of Korea, Economy Statistics System

The GDP of ROK in 2000 was 578,664 billion won, but it increased about 20% to 693,424 billion won in 2004. However, fisheries industry, GDP decreased 8.8% from 2,155 billion won in 2000 to 1,966 billion won in 2004 (**Fig. 25,** Table 58).

4 STATUS AND TRENDS IN MARICULTURE

4.1 Introduction

According to the reported document, it was around 300 years ago when a commercial aquaculture was first practiced in Korea. A culture of seaweed species, *Porphyra* sp. appeared in estuarine waters on the southern coasts of the peninsula. Pacific oyster, *Crassostrea gigas*, has also hundreds of aquaculture history. The science-based research activities were initiated since 1929 when Jinhae Inland Fisheries Research Institute of National Fisheries Research and Development Institute (NFRDI) was organized, focusing on freshwater finfish including common carp. The aquaculture research activities for freshwater finfish had contributed to the development of mariculture. NFRDI and Bukyong National University played a central role in the mariculture development in Korea. Hatchery-based seed production is primary element for recent aquaculture because advanced aquaculture technology is based on a mass production from hatchery-based seeds. More than ten marine hatcheries which were re-organized as specialized research centers belonging to NFRDI have taken some parts in technical aspects of the hatchery-based seed production technology. Due to the efforts, commercial hatcheries have thrived in Korea, providing fish and shellfish farmers with the seeds for aquaculture.

Aquaculture is poised to become an important source of marine protein that Koreans need presently and in the future. Because the capture fishing industry has peaked and is likely to decline as wild stocks are diminished, aquaculture will become a growing source of seafood products. Already, a considerable percentage of all aquatic products consumed in Korea are coming from aquatic farms. For some species, the production totally comes from aquaculture activities in the country. The aquaculture industry of Korea, however, is not without problems. Outbreaks of diseases and harmful algal blooms in the farming grounds occur annually. However, efforts to get through the problems are continuous, using environmentally sound aquaculture practices. Approach to molecular biology and genetics is of recent interest in the practice of modern aquaculture.

4.2 Production and history of mariculture

Mariculture production in the Yellow Sea (YS) coast of Korea reaches 208 x 10^3, or 22.7% of total national mariculture production in 2004. Of these, seaweeds take a considerable part of total marine aquaculture. The yield of seaweed is 145.9 x 10^3 MT, or 70.1% of the total YS mariculture production. The farmed production of finfish, crustaceans, and molluscs occupy 3.9%, 0.5% and 25.5% respectively. Of the marine farmed production, shellfish are of interest in the Yellow Sea coast of Korea.

4.2.1 Shellfish

Production of shellfish in the YS coast in 2004 reached 53 x 10^3 MT, making up 27.2% of the national shellfish production. Two shellfish species, Pacific oyster and Manila clam have been major bivalves in YS mariculture industry. Production of these two species occupied 91.7% of the total YS shellfish production.

Oyster aquaculture has been a traditional practice and has taken considerable parts of total shellfish production in Korea. For the culture of Pacific oysters, *Crassostrea gigas* seeds are obtained both from wild collection and hatchery. Hatchery based seeds are commercially available from 1990s and now increasing numbers of oyster farms are using the hatchery-based seeds.

Farming grounds of Manila clam, *Ruditapes philippinarum* in the Yellow Sea coast are normally selected sandy-silt or muddy-gravel bottoms from the intertidal zone to

2 meters in depth. Most of farming for Manila clam is in Chungcheongnam-do, Jeollanam-do and Jeollabuk-do. Almost all the seedlings for aquaculture have been caught from wild habitat in Taean, Boryeong, Dangjin and Hongseong in Chungcheongnam-do. Recently, because of reduction in wild seedling resources at natural habitat in Korea, demands for import of juveniles from China and North Korea are being increased. In addition to natural seedling catches, artificial hatchery-based spat producing techniques are already developed by NFRDI, but development of mass producing techniques in the field (for example in dike pond or tidal flat habitat) still remain as a problem to be solved

4.2.2 Finfish

The total farmed finfish production in YS coast reached 8,049 MT in 2004 and occupied comparatively small parts of total mariculture production in the west coast of Korea. Two marine finfish, olive flounder and black rockfish, dominate all the finfish species farmed in Korea. Production of these two species consists of 76.1% of total finfish production. Other minor farmed species are sea bass (*Lateolabrax japonicus*), mullet (*Mugil cephalus*), black sea bream (*Acanthopagrus schlegeli*) and parrot fish (*Oplegnathus faciatus*).

Olive flounder, *Paralichthys olivaceus*, is one of the most important marine species cultured in Korea. Flounder culture is totally based on the hatchery seeds, and is mostly practiced in the flow-through system of land-based facilities. Conditioning strain-good broodstocks for seed production is one of the key issues in the flounder aquaculture. The flounder, together with black rockfish, has been a key marine finfish species cultured in this country since late 1980s. With an aid of the advanced aquaculture technology on this species, particularly on the conditioning technology of the broodstocks in captivity, the production of the species is totally under control. However, some items, such as how to effectively control diseases and how to get better broodstocks are on-going subjects which need continuous research. Although the aquaculture for the olive flounder started from late 1980s, its commercial production was from the beginning of the 1990s in Korea. Soon after the industrialized production, the Korean production exceeded Japanese and maximized by the year 1997, thereafter showing a decreasing trend.

Black rockfish, *Sebastes schlegeli* has been studied since 1986 by NFRDI for aquaculture purpose. Currently, its artificial seedling cultivation method has been established. The rockfish together with olive flounder, occupies leading species farmed in the west coast of Korea.

4.2.3 Seaweeds

Seaweeds have long history of aquaculture and have been important aquatic products in Korea. The seaweed production in YS coast reached 145.9 x 10^3 MT in 2004 and occupied 70.1% of the total mariculture production in the west coast of Korea. The two species, laver (*Porphyra*) and sea mustard (*Undaria*) occupied 92.5% of the total seaweed production. Other minor cultured species are kelp (*Laminaria*), fusiforme (*Hijikia fusiforme*), and green algae (*Enteromopha*).

There are about 16 species of *Porphyra* growing on the coast of Korea. Common cultivated strains of *Porphyra* in Korea are *P. yezoensis, P. tenera* and *P. kuniedae*. History of seaweed culture began with Porphyra in Korea. According to the oldest records on Porphyra the alga was processed by chopping and drying earlier than 1425. Another story, passed from generation to generation, tells that it was in 1623-1649 that Porphyra was cultivated around Taein Island when a fisherman found some floating bamboo twigs with Porphyra attached to them and began his own cultivation by planting bamboo twigs along the sea shore. This bamboo twig cultivation method was used until 1986 around Taein Island and its vicinity on the south coast. The method is no longer in use.

In Korea there are two forms of Undaria, i.e. southern and northern types. Compared to the southern form, the northern form has a longer stipe with sporophylls arising from the lower region with a deeply divided blade. This morphological character has very important implication for the efficiency of Undaria processing. In the early stages of Undaria cultivation, the selection of morphologically dominant strains for artificial seeding was considered to be important. However, most farmers disregarded this fact after the success with mass production of Undaria. The influence of plant morphology is being seriously reviewed in order to encourage strong competition in Undaria cultivation and marketing. Technology of artificial Undaria seeding was first developed in 1967.

4.2.4 Crustaceans

Crustacean culture in Korea is primarily of penaeid shrimps. Two penaeid shrimps, fleshy prawn (*Fenneropenaeus chinensis*) and Kuruma prawn (*Penaeus japonicus*), have been cultured for decades in western and southern coasts of Korean peninsula. Shrimp farming was initially begun in the 1960s in Korea and the farming industry was developed in the 1980s. Farmed shrimp production has been rapidly increasing since 1990s. More than 90% of shrimp farms are located in the western coast and the rest are along the southern coast.

Two species, fleshy shrimp and Japanese Kuruma shrimp had been cultured before the middle of 1990s, but Kuruma shrimp had not been cultured since the introduction of WSSV (white spot syndrome virus) into Korea in 1993. Pacific white shrimp (*Litopenaeus vannamei*) was firstly introduced from U.S.A. in 2003. NFRDI imported three hundreds of SPF (specific pathogen free) broodstock from Hawaii, U.S.A. in 2003, succeeded with production of post-larvae and grew up to commercial size. For commercial purpose some shrimp hatcheries began to import SPF broodstock from 2004 and the potential of white shrimp farming is expected to rapidly increase in next few years.

5 ANALYSIS OF NATIONAL LAWS AND REGULATION ON FISHERIES AND MARICULTURE

5.1 Rearing of raising fisheries resources

- Marine farming act was drafted in 2002.

In managing source preservation zones for fisheries resources of territory arrangement and usage orders, considerably important areas are managed according to the specifications as the source preservation zones for fisheries resources to protect fishery ecosystem and rear fishery sources eco-friendly.

In fish-farming area cleaning order to improve fishery environment, policies about cleaning of raising Fishery grounds and special supervising fishery are continually under way.

In prevention of fish farming damage by red tide, establishment of governmental general policy about red tide prevention is continually undertaking. And fishermen who were damaged by red tide are supported by the law about agriculture-fishery damaged measures.

5.2 Enhancement of fishery resource

5.2.1 Fish-farming facilities blocked by artificial banks

To enlarge fishery income by aqua-culturing of fishery resource in semi-natural environment facilities, building of unnatural fishing bank facilities were established in 1971, and then has been promoted quickly. Now 56 % of the total planned amount is attained. The total area of the fish-farming facilities along Korean west coastal area was 5,249 ha and the products from the facilities was 38, 343 million won in 2003 (Table 1).

Table 1. Fish –farming facilities blocked by unnatural banks by region

Unit: ha, a million won

Region/City	Area	Amount
Incheon city	32	2,043
Gyeonggi province	528	3,993
Chunnam province	512	2,473
Jeonbuk province	1,115	7,037
Gyungbuk province	428	3,270
Gyungnam province	886	6,171
TOTAL	5,249	38,343

Source: Resource managing part of MOMAF (2003)

5.2.2 Nursery facilities and produced seeds

Until now, 19 national-local fishery nursery facilities along the Korean west coastal area were built. 1,194 millions of the seeds were produced in the facilities. Among them, 126 millions were released in the seas to enhance the natural fisheries resources (Table 2).

Table 2. Released seeds and regional nursery supporting in 2003

	Released amount (1,000 ind.)	Supported amount (1,000 won)		
		TOTAL	National treasury	Local tax
Incheon city	684	554,246	387,972	166,274
Gyeonggi province	910	442,857	240,000	202,857
Chunnam province	247,934	507,277	355,094	152,183
Jeonnam province	27,887	392,434	264,064	128,370
Jeonbuk province	11,998	773,557	541,490	232,067
TOTAL	126,302	4,790,295	3,991,158	799,137

Source: resource managing part of MOMAF

5.2.3 Restructure control of fisheries

- Restructure control of Off-shore, coastal fishery

The main contents of offshore, coastal fishery structure reorganization policy by MOMAF are as follows:

- Reorganizing type of off-shore, costal fisheries
- Reset up the regulation on the closed fishing areas by fishery or local government policy
- Maintenance of optimum fishing intensity for sustainable utility of the fisheries resources
- Maintenance of proper fishing efforts based on limited license and pay-back polices and apply non-fish period by fishery
- Establishing of scientific fishery management system based on accurate stock research and assessment, yield-report system, using named fishing net by fisherman
- Development and diffusion of eco-friendly fishing methods and tools, and reduce human effort to fish
- Reasonable and systemic support for fishermen

- Recovering fishery sources

Community-self fishery management has been applied since February 2001. The communities participated in this scheme have been gradually increased to 122 in 2005 (Table 3).

Table 3. Number and support status of self-management fishery communities

unit: hundred million won

		TOTAL	Incheon city	Gyeong-gi	Chung-nam	Jeon-buk	Jeon-nam	Gyung-buk	Gyung-nam
Number of communities		122	7	3	6	9	38	15	16
Raising status	Number of supported communities	58	4	2	2	3	24	7	5
	Business cost	98	3	3	4	9	36	14	7

Source: resource managing part of MOMAF

TAC (Total Allowable Catch) system was started to be applied to 4 species such as chub mackerel, horse mackerel, red tanner crab and sardine in 1999, after then the management system has been expanded gradually to 9 species in 2003. The status of TAC based fishery management system in 2004 was showed as Table 4. Calculated ABC (Allowable Biological Catch) of chub mackerel was the highest as 120,000 ~ 155,000 t and it of sardine couldn't be estimated because the landing of the species was too law. The allotted volumes as TAC by species were 155,000 t chub mackerel, 10,000 t horse mackerel, 5,000 t sardine, 22,000 t red tanner crab, 1,000 t tanner crab, 8,000 t purplish clam, 2,500 t pen shell clam, 2,150 t top shell and 13,000 t for blue crab. The exhausted rate by species were 97.6% chub mackerel, 99.3% horse mackerel, almost 0% sardine, 103.4% red tanner crab, 78.0% tanner crab, 57.9% purplish clam, 69.6% pen shell clam, 78.5% top shell and 6.8 for blue crab. The reasons why the exhausted rates were not approximate to 100% or over than it were that the system is still on a base step to be applied in Korean fishery management system, so the government tries to lead the fishermen to participate in the system, therefore the government couldn't set up strong restrictions for the system, other one was that the fishermen tried to landing as much as they want. Therefore, the government is struggle making compromises with the fishermen. The system has been changed positively, so it would be appropriately settle down in Korean fishery management system in the near future.

Table 4. TAC status by species in 2004

unit: ton, %

Species (Order) / Scientific name	ABC	TAC	Exhausted rate
Chub mackerel (Perciformes) ***Scomber japonicus***	120,000~155,000	155,000	97.6
Horse mackerel (Perciformes) ***Trachurus japonicus***	6,800~10,200	10,000	99.3
Sardine (Clupeiformes) ***Sardinops melanostictus***	-	5,000	0.0
Red tanner crab (Decapoda) *Chionoecetes japonicus*	14,000~21,000	22,000	103.4
Tanner crab (Decapoda) ***Chionoecetes opilio***	800~1,000	1,000	78.0
Washington Purplish clam (Veneroida) ***Saxidomus purpurata***	8,019	8,000	57.9
Pen shell clam (Mytilidae) ***Atrina pectinata***	4,877	2,500	69.6
Top shell (Archaeogastropoda) *Ocellatopoma japonica*	1,846~2,335	2,150	78.5
Blue crab (Decapoda) ***Portunus trituberculatus***	13,800	13,000	6.8

Source: resource managing part of MOMAF

5.2.4 Status and revision of fisheries law

- Revision of subordinate fisheries laws

Details of the Preservation Ordinance of Fisheries Resource (Presidential decree No. 18095, 27 August 2003) are as follows:

It is restricted to use more than double gill net in Korean West Sea

It decided standards of 'Net-knot' Size in Coastal Fishery and Inland waters Fishery (Long bag set net & Pound net with the transverse crib)

It set up a Capturing & Picking forbidden period of Chinese mitten crab and Lenok

It settled business license figures such a Class as Large Scale Danish Seine Fisheries of Inshore Fishery

For the transitional measure of Fisheries agreement, it could limit cultivating industry.

TAC Resource Management of Landinging fisheries can takes a Selling or Exchange according to Minister of Maritime Affairs & Fisheries.

By an Enforcement Ordinance of Fisheries Law (Presidential decree No. 18121, 4 November 2003), it expands Qualification criteria of Landinging fisheries transporter and Improved upon the defect of standing system.

By The Relating Rule of Fisheries License & declaration (Ministry of Maritime Affairs &Fisheries decree No. 247, 29 May 2003), the License of Inshore Fishery or Deep-Sea Fishery permitted Fishing Boats can fish in the restricted waters of foreign country.

- Status of raising fishery cultivating law

In an Enforcement Ordinance of Raising Fishery cultivating Law (Presidential decree No. 18052, 15 July 2003), Minister of Maritime Affairs & Fisheries or City & Provincial governor decides method and contents of basic investigation for the Setting of 'Raising Fisheries Developing Plan'.

The Rule of Raising Fishery Cultivating Law (Ministry of Maritime Affairs & Fisheries decree No. 251, 15 July 2003) decides the choice, method and procedure of Fisheries Developing Area.

- Status and revision of others notification

By the Notification about jellyfish discharging net in costal sea Stow net (2003-1, NFRDI Notification), In the Article No.6 (1)-h of fishery resource protection ordinance, to preserve fishing net damage from over-incoming of jellyfish, necessary matters to protect them are arranged to stick discharging net in coastal sea Stow net.

And the Notification about designating type of fishery in TAC system, by 2 of Article No.54 fishery law, the No. 18 of fishery resource protection ordinance, 2 of Article No. 27 (4) and Article No.27 (4), kinds of TAC applicant fishery, designating selling place and managing way of TAC system were arranged.

6 PRELIMINARY GOVERNANCE ANALYSIS

The Yellow Sea is semi closed sea surrounded by South Korea, North Korea and China and located to the north of the East China Sea and connected to the Bohai Bay in northward. Therefore, the sea must be shared among the four countries included some part of Japan. Japan can use the sea with permissions from the countries.

The Yellow Sea is mostly composed of shallowness of the continental shelf water and productive. Biodiversity of fishery resources in the sea is high with about 450 species. Commercially important fishery resources are about 50 species in Korean and Chinese fisheries.

Most of the fishery resources in the Yellow Sea, except some sedentary resources and cold water species, migrate seasonally for wintering, spawning and feeding. After wintering in the southern Yellow Sea and the northern East China Sea, fishes migrate to the coastal area for spawning and feeding from spring through autumn, and then move back to the wintering area in late autumn. Therefore, the Yellow Sea and its marginal zones, and the coasts of Korea and China, are very important for the fishery of the Yellow Sea.

The fishing efforts have been increased very much, especially the most rapid development of fishing efforts in South Korean fisheries occurred in the power of the boats. Therefore, even though the number of fishing boats decreased, fishing intensity has been increased.

However, most of landings in Korea from the Yellow Sea have been decreased since mid 1980s in general. Species composition of landings has been changed from large size and relatively higher tropic level of demersal species (like small yellow croaker, largehead hairtail) to small and lower tropic level of pelagic fish like anchovy.

Most commercially valuable fish stocks in the Yellow Sea have been overexploited due to both a continuous increase in fishing capacity in adjacent waters and near shore fish habitat deterioration because of large land reclamations, municipal and industrial waste discharges. Korean and Chinese fishermen have increased competitively their fishing effort as their landings decreased, it has accelerated the depletion of fish stocks in the Yellow Sea.

As the landing and fisheries products decreased, imports increased, and then mariculture was considered to compensate the reduction of the products from the natural resources. At first mariculture products increased as the methods developed, but recently it started to be decreased. Mariculture becomes one of the causes of environment problems such as diseases, pollution because of fish food and so on, so it has been restricted by the license (included permission and notification) systems and some of its products are under control.

According to the fisheries products declined, ecosystem health becomes worse and the fishing grounds reduced because exclusive economic zone (EEZ) was declared, Korea acknowledged the importance of the resources conservation and management. In order to cope with this fisheries environment, the Korean government has applied various resource enhancements tactics.

They include protection of spawning grounds, purification and management of coastal areas, exclusion of illegal fishery, releasing fish seeds of artificially hatched relatively sedentary species. Prohibition of targeting particular species in specific areas, seasonal restrictions, and fish size limitation are other types of management strategies. Regulations on fish licensing and mesh size have also been applied for better sustainable production. Simultaneously large meaning of Marine Protected Area and community-self fishery management policies are adopted. The Korean singleness management methods, however, haven't worked well.

The resources and oceans in the Yellow Sea have been shared among the surrounded countries such as South Korea, North Korea, China and Japan. Therefore, it is necessary to establish appropriate and collaborative management system with the countries together to utilize and preserve the resources and ocean effectively based on cooperative research survey results and ecosystem based management.

7 DATA AND INFORMATION GAPS

To effectively preserve the resources and ocean and reduce the stress in the Yellow Sea, it is necessary to establish collaborative management system among the surrounded countries together. However, until now there haven't been any opportunities to carry out comprehensive and partnership management system on the fisheries.

To consider appropriate strategies for fisheries resources conservation, it is a base step to understand the Yellow Sea ecosystem. Thus, first of all, collection of data and information on the fisheries, mariculture and socio-economic is carried out, but we found there are some data and information gaps.

7.1 Accuracy fishing sites and catch mount

To analysis stock size and discuss appropriate management way properly, it is necessary to get exact data about where what kind of fish and how much the fishermen catch. There aren't any available exact catch data by fishing sites, because most fishermen want to keep the information on their fisheries as their own knowledge to catch more by themselves in the future. Therefore, it is needed to set up special fishing report systems to get more accurate data.

7.2 Discards

Most of fisheries scientists want to know discard for exact stock assessments, but it is very difficult to get the data for them without any observer systems. In Korea there is an observer system, but it doesn't have enough potentiality to obtain the appropriate data on the fishing boats for precise stock assessments. Now the government recognizes it is necessary to expend the system to get more accuracy data and information. The government is planning it.

7.3 Cooperative survey for fisheries resources

Even though the scientists get commercial fishery dependant data, it is very difficult for them to standardize the fishing efforts among the data form fisheries and countries, it only depends on fishermen's report or landing data, and then the data from each country has its own way, the quality of the data is different. Therefore, it is needed to set up cooperative surveys between Korea and China to calibration the exist data.

7.4 Socio-economic data format

There was some point of difference about static system management between Korea and China. Korean static system has more detailed data and information, but China system barely has requested data because of the difference from managing static system. So we modified the data format of socio-economic department in the 2nd RWG meeting.

7.5 Total production of marine farmed organisms

Production of farmed animals and seaweeds were investigated for seafood sold or distributed through the assignment sale of the Fisheries Cooperative. When farmed production sold directly on local farms is included, total production will increase up to about 10-30% depending on the species.

Changes in total production of marine farmed organisms from the west coast during last 10 years are compared with that of total national mariculture production. Total national production of freshwater is compared with mariculture production.

7.6 Aquaculture area of marine farms

There are three types of permission regulation for aquaculture farms in Korea, i.e. licensed, permitted and notified farms. The licensed farms are legally permitted until 1997 and the regulation of permission and notification had begun since 1998. Therefore data of aquaculture area include licensed farms only until 1997 and include three types of farms (license, permission and notification) from 1998.

Collective farms are another type of permission. This is very huge in size and belongs to a village or cooperative association of fisheries. These types of farms culture mainly shellfish or shellfish/seaweeds. There are little data on area of collective farms during 1995 – 2000. Therefore the available data on the area is included from 2001 to 2004.

7.7 Aquaculture methods (habitats) of marine farmed organisms

Data on the area for aquaculture methods is based on the aquaculture area of marine farms, i.e. data on area of each culture method include licensed farms only before 1998 and include licensed, permitted or notified farms from 1998 to 2004. Data on collective farms are same to the aquaculture area of marine farms.

- FINFISH

Finfish are cultured by land based tank or outdoor pond methods.

- CRUSTACEANS

Crustaceans (shrimp) are cultured from outdoor ponds only. There are various methods in shellfish culture. Hanging culture method is applied to scallops, oysters, abalones and mussels. Bottom culture method is applied to clams, oysters and abalones. Cage culture and land based tank culture methods are applied to abalones only. Data on the area for each culture method of shellfish is available in 2004 only.

- SEAWEEDS

Seaweeds are mainly cultured by floating net or long-lined method in the bay or open sea.

- SEA CUCUMBER

Culture of sea cucumbers is recently developed in the west coast of Korea. Polychaetes (bloodworms) are mainly cultured in ponds and very few in land based facilities. Sea urchins is not cultured in the west coast but released in the east coast to improve wild resources.

Collective farms are cultured by short-necked clam, abalone or seaweeds. Polyculture of seaweeds (*Laminaria* sp.) with abalone is sometimes carried out in collective farms. However short-necked clam is cultured in most collective farms.

The farmed area was investigated for the legally permitted farms only. When illegal farms are included, total figures will increase up to about 10% depending on the species.

8 PRELIMINARY CAUSAL CHAIN ANALYSIS

Problem	Impacts	Immediate Causes (Technical)	Underlying cause	Root cause	Governance	Priority rank (H, M, L)	Trans-boundary?	If yes, priority rank (H, M, L)
Decline in CONDITIONS of Many Commercially Important Fishery Species	*Reduction in tropic level, Reduction in overall size of some commercially valuable species, Change in composition of species*	Over-exploitation of target species	Insufficient management and control of fisheries activities, Over-Capacity of fishing fleets, Illegal Fishing, Insufficient monitoring and enforcement, weak scientific-based knowledge on status of stocks	Increasing demand for marine resources due to rapid population and economic expansion	Insufficient legal instruments at national and regional levels, insufficient implementation of national regulatory instruments; lack of regional harmonization of regulations. Insufficient knowledge and infrastructure base	H	Y	H
Uncontrolled Aquaculture Practices	*Damage to coastal natural habitat; damage to environmental quality, Introduction of pathogens, increase in disease outbreak*	*Over-intensive aquaculture activities and Over-exploitation of natural habitats, Introduction of foreign species*	Increasing mariculture activities, Effect of mariculture activities on surrounding habitats	Increasing demand for marine resources (mariculture products) due to rapid population and economic expansion	Inadequate legal instruments at national and regional levels, inadequate implementation of national regulatory instruments; lack of regional harmonization of regulations. Inadequate knowledge and infrastructure base	H	Y	H
Inadequate Capacity to Assess Ecosystem	*Incapacity to adequately manage activities and management resources, and mitigate effects*	Insufficient information and environmental impact assessments	Insufficient knowledge and infrastructure base	Poor regional coordination, communication and collaboration, insufficient financing mechanisms and support	Insufficient understanding and associated policies	M	Y	M

9 SUMMARY

The Yellow Sea is a highly productive sea consisted of mostly continental shelf, so it is used as spawning and nursery grounds by the fisheries resources. Therefore, the sea is impacted very intensively due to land-based activities.

Most commercial important species in the Yellow Sea showed seasonal distribution pattern and migration routes excluding some species inhabit the cold water mass and sedentary species in the coasts.

The total landing of Korea was shown the highest level in mid-80s, after that time it was gradually decreased until the recent year. And the landing of almost commercially important species except anchovy also showed gradually decreasing trends. The ratio of Yellow Sea/Total landing is about 20% in recent years.

Although the fishing vessels and KW were increased, the tonnage was decreased in recent years. The CPUE (landing / boats, HP) are decreased sharply in recent years, but the landing / GT maintained some stable condition.

In species composition the dominant species was changed from large demersal species to small pelagic species as decades passed by.

According to the socio-economic statistical data, most items are decreased during last 5 years. The import of marine product increased more than export and that decreased contribution of marine industry to GDP, it showed the task of Korea fishery industry.

Production of farmed animals and seaweeds were investigated for seafood sold or distributed through the assignment sale of the Fisheries Cooperative.

There are three types of permission regulation for aquaculture farms in Korea, i.e. licensed, permitted and notified farms. The licensed farms are legally permitted until 1997 and the regulation of permission and notification had begun since 1998.

Finfish are cultured by land based tank or outdoor pond methods. Crustaceans (shrimp) are cultured from outdoor ponds only.

There are various methods in shellfish culture. Hanging culture method is applied to scallops, oysters, abalones and mussels. Bottom culture method is applied to clams, oysters and abalones. Cage culture and land based tank culture methods are applied to abalones only. Seaweeds are mainly cultured by floating net or long-lined method in the bay or open sea.

Culture of sea cucumbers is recently developed in the west coast of Korea. Polychaetes (bloodworms) are mainly cultured in ponds and very few in land based facilities. Sea urchins is not cultured in the west coast but released in the east coast to improve wild resources.

Collective farms are cultured by short-necked clam, abalone or seaweeds. Polyculture of seaweeds (*Laminaria* sp.) with abalone is sometimes carried out in collective farms. However short-necked clam is cultured in most collective farms.

In the Korea domestic law part, we can find the law about rearing of raising fishery, formation of fishery resource and fishery structure control. Also, there was some revision in the Preservation Ordinance of Fisheries Resource, Statute of Raising Fishery cultivating Law and jellyfish discharging net in coastal sea Stow net.

We established policies as stated in Table 1, such as reformation of types of industry, adjustment of fishery zone, maintenance of fishery skill, maintenance of appropriate fishery boat power, constructing of scientific fishery controlling system, building of environmental friendly fishing environment, and introduction of new fishing technique.

Table 5. Sustainable fishery policy

Strategy plan	Details
1. Reformation of industrial types	-Categorization should be modified (Types of fishery and naming)
2. Adjustment of fishery zone	-Modification of fishing prohibition zone
3. Maintenance of fishery skill	-Restriction of shipping volume -Limit of the power in institute at certain point
4. Maintenance of appropriate fishery boat power	-Modify the number of fishing certificate
5. Constructing scientific fishery controlling system	-Real name system of fishing implements -Scientific research and evaluation of near coastal line
6. Building of environmental friendly fishing environment, and introduction of new fishing technique	-Adoption of VMS -Development of fish exit instrument

The resources and oceans in the Yellow Sea have been used among the surrounded countries such as South Korea, North Korea, China and Japan, together. Therefore, it is needed to set up appropriate and collaborative management systems among the countries to share and preserve the resources and ocean effectively based on the cooperative surveys between Korea and China.

10 LOCATION OF DATA & INFO AND ACCESS TO THE SITE BY THE PUBLIC

Fisheries

- Agriculture, Fisheries and Forest Bureau, Incheon city Government for the fishing effort (No, tonnage and HP of boats) data in Incheon city
- Agriculture, Fisheries and Forest Bureau, Gyeonggi Provincial Government for the fishing effort (No, tonnage and HP of boats) data in Gyeonggi province
- Agriculture, Fisheries and Forest Bureau, Chungnam provincial Government for the fishing effort (No, tonnage and HP of boats) data in Chungnam province (Chungchungnam-do)
- Agriculture, Fisheries and Forest Bureau, Jeonbuk provincial Government for the fishing effort (No, tonnage and HP of boats) data in Jeonbuk province
- Agriculture, Fisheries and Forest Bureau, Jeonnam provincial Government for the landing and fishing effort (No, tonnage and HP of boats) data in Jeonnam province focused on Mokpo-city and Sinan-gun
- National Fisheries Research and Development Institute (NFRDI) in Busan for the CPUE by fisheries, biological and ecological data of each species
- South Sea Fisheries Research Institute in Yeosu for the CPUE by fisheries, biological and ecological data each species
- **West** Sea Fisheries Research Institute in Inchon for the CPUE by fisheries, biological and ecological data each species
- Bukyong, Yeosu and Mokpo National Universities for some analyzing methods, biological and ecological data of each species in Busan, Yeosu and Mokpo

Socio-economic

- The Ministry of Maritime Affairs and Fisheries, Fishery Trend Annual Report
- The Ministry of Maritime Affairs and Fisheries, Marine Product Supply-Demand and Price Annual Report
- The National Statistical Office, Fisheries Statistical Analysis
- The National Statistical Office, Fisheries Household Economy Statistical Analysis
- The Bank of Korea, Economy Statistic System
- Korea Rural Economic Institute, The Table about demand and supply of Korean Food
- The Customs Service, Import and Export Statistics

Mariculture

- Aquaculture Development Division, Ministry of Maritime Affairs & Fisheries for total marine farmed production in Korea
- Fisheries Management Division, Incheon Regional Maritime Affairs & Fisheries Office for the status of licenses and area of marine farmed organisms in Incheon city
- Fisheries Management Division, Pyeongtaek Regional Maritime Affairs & Fisheries Office for the status of licenses and area of marine farmed organisms in Gyeonggi province
- Fisheries Management Division, Daesan Regional Maritime Affairs & Fisheries Office for the status of licenses and area of marine farmed organisms in Chungnam province

- Fisheries Management Division, Gunsan Regional Maritime Affairs & Fisheries Office for the status of licenses and area of marine farmed organisms in Jeonbuk province
- Fisheries Management Division, Mokpo Regional Maritime Affairs & Fisheries Office
- Agriculture, Fisheries & Forest Bureau, Incheon city Government for the status of licenses and area of marine farmed organisms in Incheon city
- Agriculture, Fisheries & Forest Bureau, Gyeonggi provincial Government for the status of licenses and area of marine farmed organisms in Gyeonggi province
- Agriculture, Fisheries & Forest Bureau, Chungnam provincial Government for the status of licenses and area of marine farmed organisms in Chungnam province
- Agriculture, Fisheries & Forest Bureau, Jeonbuk province Provincial Government for the status of licenses and area of marine farmed organisms in Jeonbuk province
- Agriculture, Fisheries & Forest Bureau, Jeonnam provincial Government for the status of licenses and area of marine farmed organisms in Jeonnam province with focus on Younggwang-gun, Muan-gun, Hampyeong-gun, Sinan-gun and Mokpo City.
- Area for data collection is shown in Fig. 11. Four provinces of five investigated, i.e. Incheon city, Gyeonggi province, Chungnam province, Jeonbuk province, are located in the west coast. However Jeonnam province has both coast of south and west. Five local sub-provinces of Jeonnam, i.e. Younggwang-gun, Muan-gun, Hampyeong-gun, Sinan-gun and Mokpo City, located in the west coast are included to this data collection.

Access to Websites

In Korea, there are several websites to be accessed by public, which are:

http://www.momaf.go.kr/: public

http://kosis.nso.go.kr/: not public

http://infofishnet.co.kr/: public

http://fs.fips.go.kr/: public

http://www.bok.or.kr: public

They disseminate some of data or **information** on fisheries **statistics** such as landings by species, fishery and region, number of fishing boats, gross tonnage and horse power of fishing vessels, and aqua-farming *ect*.

11 DATA AND INFORMATION TABLE

11.1 Area for data collection

The data and information were collected and analyzed from each institute (National Fisheries Research and Development Institute, South Sea Fisheries Research Institute), National Federation of Fisheries Cooperatives (Incheon city, Gyeonggi province, Chungnan province, Jeonbuk province, Jeonnam province), universities (Pukyong, Yeosu and Mokpo National University, Kyoung Sang University) and local government (Incheon city, Gyeonggi province, Chungnan province, Jeonbuk province, part of Jeonnam province) corresponding to the Yellow Sea (Fig. 20).

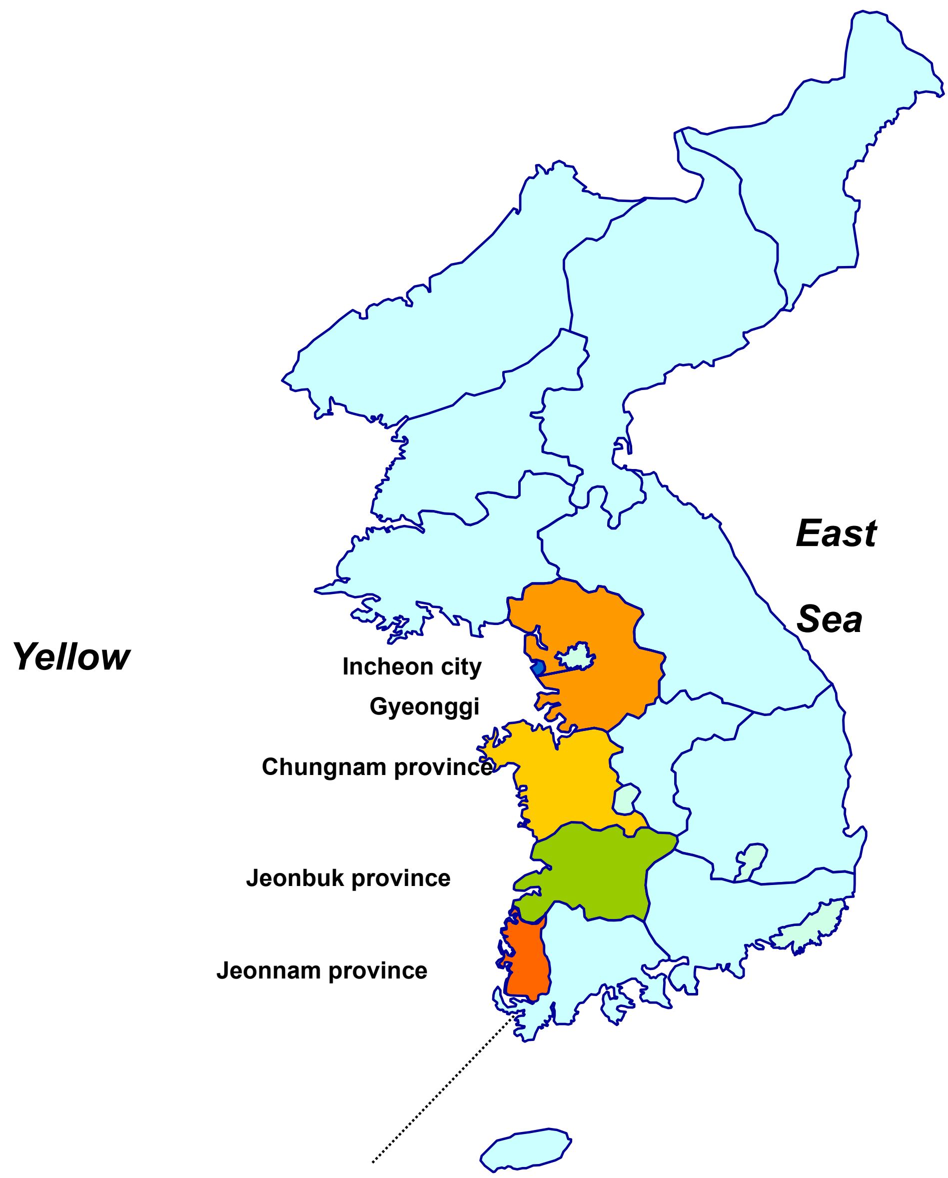


Figure 21. Map showing five provinces bordering the Yellow Sea coast of south Korea. Only five sub-provinces of Jeonnam province belong to the Yellow Sea coast (see red area).

11.2 Collected data and information on fisheries

11.2.1 Collected data and information on Fisheries

- Landing trends of the total and by species

Table 6. Landings (in metric ton) by commercially important 10 species and total, 1986~2004

Year	Small yellow croaker	Spanish mackerel	Anchovy	Chub mackerel	Largehead hairtail	Pacific herring	Sandlance	Acetes	Fleshy prawn	Squids	Total
1986	2,601	1,862	28,007	2,466	50,382	17	0	11,375	964	30,404	128,077
1987	6,243	1,685	30,519	3,798	56,940	14	0	13,712	437	28,646	141,992
1988	4,777	856	21,472	5,049	48,984	2	0	8,417	517	22,466	112,537
1989	5,404	1,382	19,831	4,379	48,374	14	0	16,192	775	15,029	111,379
1990	9,369	1,643	21,101	1,635	47,201	12	1	17,627	833	14,957	114,378
1991	16,182	1,101	27,108	1,107	45,275	3,531	10	13,936	972	14,903	124,123
1992	13,887	869	26,046	3,187	35,515	1	101	14,940	954	10,054	105,552
1993	9,616	648	38,701	6,933	24,065	0	91	20,411	784	7,881	109,127
1994	14,189	801	29,747	7,018	34,145	0	280	14,111	1,078	7,209	108,575
1995	7,713	617	32,486	6,339	22,430	0	1,334	13,609	1,227	5,014	90,767
1996	8,204	228	50,392	12,641	14,671	0	1,054	12,827	1,018	4,903	105,936
1997	7,559	343	42,900	2,292	11,525	3	896	10,576	1,562	5,484	83,138
1998	4,709	627	41,422	2,732	13,378	9	0	11,916	974	9,874	85,639
1999	4,600	543	53,533	2,471	7,314	0	6	16,309	738	8,295	93,807
2000	6,266	739	48,446	2,587	6,846	0	11,956	10,662	1,044	3,637	92,181
2001	2,595	930	49,427	6,684	5,285	2	328	8,632	420	6,182	80,483
2002	2,988	988	53,808	2,831	2,919	9	2,118	4,659	207	6,816	77,341
2003	2,462	1,035	35,899	1,459	4,910	0	2,003	8,530	123	6,683	63,102
2004	6,110	1,002	41,477	3,330	9,195	2	222	5,182	702	8,065	75,283
Mean	7,130	942	36,438	4,154	25,755	190	1,074	12,296	807	11,395	100,180

- Trends of fishing efforts

Table 7. Number, tonnage and power (in KW) of fishing vessels, 1986~2004

Year	Powered Vessel				Non-powered Vessel			Total		
	No.	Tons	KW	Tons/ Vessel	No.	Tons	Tons/ Vessel	No.	Tons	Tons/ Vessel
1986	26,596	157,880	648,509	5.94	6,518	9,798	1.50	33,114	167,678	5.06
1987	26,992	160,348	783,403	5.94	6,865	9,937	1.45	33,857	170,285	5.03
1988	27,752	163,139	956,536	5.88	7,464	10,087	1.35	35,216	173,226	4.92
1989	27,363	153,956	1,018,517	5.63	7,192	9,426	1.31	34,554	163,382	4.73
1990	27,989	154,663	1,123,631	5.53	7,265	9,119	1.26	35,253	163,782	4.65
1991	30,198	159,391	1,349,654	5.28	7,232	8,857	1.22	37,430	168,248	4.50
1992	27,478	153,734	1,590,288	5.59	5,969	7,584	1.27	33,446	161,318	4.82
1993	25,400	151,959	1,691,061	5.98	4,561	6,127	1.34	29,960	158,086	5.28
1994	24,337	151,435	1,824,897	6.22	2,175	4,082	1.88	26,512	155,518	5.87
1995	24,632	150,485	1,975,893	6.11	1,593	2,913	1.83	26,225	153,399	5.85
1996	23,895	146,916	2,237,559	6.15	1,528	2,309	1.51	25,423	149,225	5.87
1997	23,157	143,347	2,499,224	6.19	1,464	1,704	1.16	24,621	145,051	5.89
1998	28,324	157,348	2,865,357	5.56	1,601	1,756	1.10	29,924	159,104	5.32
1999	31,627	157,899	2,703,058	4.99	1,753	1,612	0.92	33,380	159,510	4.78
2000	32,386	152,276	2,963,581	4.70	1,705	1,519	0.89	34,091	153,795	4.51
2001	32,872	148,909	3,514,806	4.53	1,476	1,270	0.86	34,348	150,179	4.37
2002	32,993	140,692	4,014,356	4.26	1,390	1,160	0.83	34,383	141,852	4.13
2003	33,136	135,677	3,924,244	4.09	1,443	1,138	0.79	34,579	136,815	3.96
2004	32,555	131,171	4,011,878	4.03	1,384	1,134	0.82	33,939	132,305	3.90
Mean	28,404	151,117	2,194,550	5.40	3,714	4,817	1.23	32,118	155,935	4.85

- Changes of species composition in landings

Table 8. Commercially important 10 species' composition in Korean total landing off the Yellow Sea from 1986 to 2004

Year	Small yellow croaker	Spanish mackerel	Anchovy	Chub mackerel	Largehead hairtail	Pacific herring	Sandlance	Acetes	Fleshy prawn	Squids	Total
1986	0.57	0.41	6.15	0.54	11.07	0.00	0.00	2.50	0.21	6.68	28.13
1987	1.46	0.39	7.14	0.89	13.31	0.00	0.00	3.21	0.10	6.70	33.20
1988	1.19	0.21	5.34	1.26	12.18	0.00	0.00	2.09	0.13	5.59	27.98
1989	1.39	0.36	5.11	1.13	12.46	0.00	0.00	4.17	0.20	3.87	28.69
1990	2.41	0.42	5.43	0.42	12.14	0.00	0.00	4.53	0.21	3.85	29.41
1991	4.04	0.27	6.77	0.28	11.31	0.88	0.00	3.48	0.24	3.72	31.01
1992	4.23	0.26	7.94	0.97	10.82	0.00	0.03	4.55	0.29	3.06	32.16
1993	2.73	0.18	10.99	1.97	6.84	0.00	0.03	5.80	0.22	2.24	31.00
1994	4.14	0.23	8.67	2.05	9.95	0.00	0.08	4.11	0.31	2.10	31.65
1995	2.61	0.21	11.00	2.15	7.59	0.00	0.45	4.61	0.42	1.70	30.72
1996	2.81	0.08	17.27	4.33	5.03	0.00	0.36	4.40	0.35	1.68	36.30
1997	2.85	0.13	16.17	0.86	4.34	0.00	0.34	3.99	0.59	2.07	31.34
1998	1.67	0.22	14.68	0.97	4.74	0.00	0.00	4.22	0.35	3.50	30.36
1999	1.70	0.20	19.83	0.92	2.71	0.00	0.00	6.04	0.27	3.07	34.75
2000	2.49	0.29	19.27	1.03	2.72	0.00	4.76	4.24	0.42	1.45	36.67
2001	1.14	0.41	21.75	2.94	2.33	0.00	0.14	3.80	0.18	2.72	35.42
2002	1.38	0.46	24.83	1.31	1.35	0.00	0.98	2.15	0.10	3.14	35.69
2003	1.09	0.46	15.87	0.64	2.17	0.00	0.89	3.77	0.05	2.95	27.90
2004	2.90	0.48	19.70	1.58	4.37	0.00	0.11	2.46	0.33	3.83	35.75
Mean	2.25	0.30	12.84	1.38	7.23	0.05	0.43	3.90	0.26	3.36	32.01

- Survey results by bottom trawl

Table 9. Annual and seasonal species composition by bottom trawl survey in Korean side of the Yellow Sea from 2003 to 2005

Major species	2003								
	Spring			Winter			Total		
	Species	Catch(g)	Ratio(W,%)	Species	Catch(g)	Ratio(W,%)	Species	Catch(g)	Ratio(W,%)
1	*Lophius litulon*	39,415	17.3	*Lateloabrax japonicus*	268,280	38.7	*Lateloabrax japonicus*	268,280	29.1
2	*Hemitripterus villosus*	37,757	16.6	*Sebastes schlegeli*	150,846	21.8	*Sebastes schlegeli*	158,017	17.2
3	*Zoarces gilli*	18,147	8.0	*Loligo beka*	68,000	9.8	*Loligo beka*	69,735	7.6
4	*Gadus macrocephalus*	15,570	6.9	*Liparis tanakai*	25,078	3.6	*Lophius litulon*	56,770	6.2
5	*Hexagrammos otakii*	10,835	4.8	*Oregonia gracilis*	19,195	2.8	*Hemitripterus villosus*	49,888	5.4
6	*Crangon affinis*	9,277	4.1	*Lophius litulon*	17,355	2.5	*Oregonia gracilis*	28,245	3.1
7	*Oregonia gracilis*	9,050	4.0	*Hexagrammos otakii*	16,236	2.3	*Hexagrammos otakii*	27,071	2.9
8	*Collichthys niveatus*	7,652	3.4	*Larimichthys ployactis*	14,690	2.1	*Liparis tanakai*	25,534	2.8
9	*Sebastes schlegeli*	7,171	3.2	*Hemitripterus villosus*	12,131	1.7	*Zoarces gilli*	19,504	2.1
10	*Conger myriaster*	6,513	2.9	*Okamejei kenojei*	11,188	1.6	*Gadus macrocephalus*	18,423	2.0

Major species	2004								
	Spring			Winter			Total		
	Species	Catch(g)	Ratio(W,%)	Species	Catch(g)	Ratio(W,%)	Species	Catch(g)	Ratio(W,%)
1	*Lophius litulon*	148,538	37.6	*Lophius litulon*	171,120	28.9	*Lophius litulon*	319,658	32.4
2	*Hemitripterus villosus*	42,019	10.6	*Collichthys niveatus*	70,170	11.8	*Collichthys niveatus*	73,100	7.4
3	*Sebastes schlegeli*	31,492	8.0	*Liparis tanakai*	58,588	9.9	*Sebastes schlegeli*	65,530	6.6
4	*Hexagrammos otakii*	19,502	4.9	*Loligo beka*	43,515	7.3	*Hemitripterus villosus*	62,189	6.3
5	*Crangon affinis*	19,393	4.9	*Sebastes schlegeli*	34,038	5.7	*Liparis tanakai*	60,881	6.2
6	*Squalus megalops*	17,060	4.3	*Oregonia gracilis*	26,638	4.5	*Loligo beka*	58,296	5.9
7	*Loligo beka*	14,781	3.7	*Cleisthenes pinetorum*	23,945	4.0	*Crangon affinis*	43,202	4.4
8	*Oregonia gracilis*	12,800	3.2	*Crangon affinis*	23,809	4.0	*Oregonia gracilis*	39,438	4.0
9	*Gadus macrocephalus*	12,102	3.1	*Hemitripterus villosus*	20,170	3.4	*Hexagrammos otakii*	30,095	3.0
10	*Cancer spp.*	6,065	1.5	*Larimichthys ployactis*	10,593	1.8	*Cleisthenes pinetorum*	26,319	2.7

Major species	2005								
	Spring			Winter			Total		
	Species	Catch(g)	Ratio(W,%)	Species	Catch(g)	Ratio(W,%)	Species	Catch(g)	Ratio(W,%)
1	*Lophius litulon*	109,665	18.4	*Lophius litulon*	127,919	31.6	*Lophius litulon*	237,584	23.7
2	*Crangon affinis*	86,045	14.4	*Crangon affinis*	29,072	7.2	*Crangon affinis*	115,117	11.5
3	*Sebastes schlegeli*	43,095	7.2	*Paralichthys olivaceus*	26,939	6.7	*Collichthys niveatus*	51,112	5.1
4	*Gadus macrocephalus*	39,100	6.6	*Loligo beka*	24,158	6.0	*Gadus macrocephalus*	48,576	4.9
5	*Squalus megalops*	34,570	5.8	*Collichthys niveatus*	21,990	5.4	*Oregonia gracilis*	46,497	4.6
6	*Ammodytes personatus*	31,052	5.1	*Oregonia gracilis*	21,277	5.3	*Sebastes schlegeli*	43,679	4.4
7	*Collichthys niveatus*	29,122	4.9	*Cleisthenes pinetorum*	16,519	4.1	*Loligo beka*	37,564	3.8
8	*Oregonia gracilis*	25,220	4.2	*Liparis tanakai*	13,735	3.4	*Hemitripterus villosus*	35,803	3.6
9	*Hemitripterus villosus*	22,847	3.8	*Hemitripterus villosus*	12,956	3.2	*Squalus megalops*	34,570	3.5
10	*Engraulis japonicus*	17,994	3.0	*Gadus macrocephalus*	9,476	2.3	*Ammodytes personatus*	33,340	3.3

Table 10. Annual and seasonal density distribution of species by bottom trawl survey in Korean side of the Yellow Sea from 2003 to 2005

Major Species	2003							
	Spring			Winter			Total	
	Mean	Range	Occurrence	Mean	Range	Occurrence	Mean	Range
Lateloabrax japonicus	-	-	-	452.0	~14,34.0	1/10	226.4	~14,340
Sebastes schlegeli	12.1	4.6~54.4	5/10	254.2	7.5~2,603.3	6/10	133.3	4.6~2,603.3
Loligo beka	2.9	0.9~11.3	6/10	114.6	0.4~527.7	6/10	58.8	0.4~255.8
Lophius litulon	66.6	43.1~244.2	6/10	42.3	6.2~214.4	7/10	47.9	6.2~244.2
Hemitripterus villosus	63.8	2.4~336.0	5/10	20.4	15.7~88.2	6/10	42.1	2.4~336.0
Oregonia gracilis	30.7	1.5~255.8	8/10	32.3	1.3~183.3	9/10	23.8	1.3~255.8
Liparis tanakai	0.8	0.1~4.7	7/10	42.3	6.2~214.4	7/10	22.8	0.1~214.4
Zoarces gilli	30.7	1.5~255.8	5/10	2.3	0.4~7.1	9/10	21.5	0.4~255.8
Gadus macrocephalus	26.3	2.7~154.1	5/10	4.8	1.6~27.8	5/10	16.5	1.6~154.1
Larimichthys ployactis	2.6	1.3~14.8	5/10	24.8	2.5~135.3	5/10	15.5	1.3~135.3

Major Species	2004							
	Spring			Winter			Total	
	Mean	Range	Occurrence	Mean	Range	Occurrence	Mean	Range
Lophius litulon	155.1	21.7~694.8	16/17	159.2	8.7~693.7	14/17	157.3	8.7~694.8
Collichthys niveatus	3.1	0.5~36.4	7/17	65.3	0.5~997.8	13/17	36.0	0.5~997.8
Sebastes schlegeli	32.9	8.7~140.0	11/17	31.7	1.1~515.4	6/17	32.2	1.1~515.4
Hemitripterus villosus	43.9	4.8~276.7	14/17	18.8	1.7~130.6	9/17	30.6	1.7~276.7
Liparis tanakai	2.4	0.1~11.6	13/17	54.5	12.0~328.6	12/17	30.0	0.1~328.6
Loligo beka	15.4	0.3~173.5	15/17	40.5	0.1~278.1	11/17	28.7	0.1~278.1
Crangon affinis	20.3	0.2~162.3	16/17	22.1	0.8~126.3	17/17	21.3	0.2~162.3
Oregonia gracilis	13.4	1.5~68.8	12/17	24.8	0.4~110.5	17/17	19.4	0.4~110.5
Hexagrammos otakii	20.4	1.4~87.8	9/17	9.9	2.1~117.6	6/17	14.8	1.4~117.6
Cleisthenes pinetorum	2.5	1.5~16.0	6/17	22.3	0.9~167.2	12/17	12.9	0.9~167.2

Major Species	2005							
	Spring			Winter			Total	
	Mean	Range	Occurrence	Mean	Range	Occurrence	Mean	Range
Lophius litulon	121.1	9.3~432.9	14/17	148.4	3.7~988.1	12/16	134.4	3.7~988.1
Crangon affinis	95.0	1.1~360.6	17/17	33.7	1.0~181.0	16/16	65.1	1.0~360.6
Collichthys niveatus	32.1	0.1~304.8	9/17	25.5	0.2~140.6	12/16	28.9	0.1~304.8
Gadus macrocephalus	43.2	3.3~198.6	8/17	11.0	2.1~64.0	6/16	27.5	2.1~198.6
Oregonia gracilis	27.8	0.3~128.9	17/17	24.7	0.3~100.3	14/16	26.3	0.3~128.9
Sebastes schlegeli	47.6	10.5~513.5	14/17	0.7	1.4~6.3	3/16	24.7	1.4~513.5
Loligo beka	14.8	0.1~58.4	16/17	28.0	0.2~223.7	13/16	21.3	0.1~223.7
Hemitripterus villosus	25.2	0.0~149.0	13/17	15.0	0.0~59.8	9/16	20.3	0.0~149.0
Aqualus brevirostris	38.2	37.3~537.8	2/18	-	-	-	19.6	37.3~537.8
Ammodytes personatus	34.3	1.2~642.1	5/19	2.7	2.7~77.7	2/16	18.9	1.2~642.1

Table 11. Seasonal distribution density in number of fish larvae and eggs by icthyo-plankton survey in Korean side of the Yellow Sea from 2003 to 2005

Major Species	2003					
	Larvae			Eggs		
	Mean	Range	Occurrence	Mean	Range	Occurrence
Engraulis japonicus	0.8	7.5	1/10	9.0	100	1/10
Sebastes schelegeli	4.6	4.9~24.0	3/10			
Limanda herzenstein	0.8	7.1	1/17			
unidentified sp.				112.3	1,037	1/10

Major Species	2004					
	Larvae			Eggs		
	Mean	Range	occurrence	Mean	Range	Occurrence
Engraulis japonicus				0.6	0.9~12	4/17
Cleisthenes pinetorum herzensteini	0.1	1.0	1/17			
Sebastes schelegeli	0.4	1.0~2.7	4/17			
unidentified sp.				16.9	5.0~204.7	2/17

Major Species	2005					
	Larvae			Eggs		
	Mean	Range	Occurrence	Mean	Range	Occurrence
Engraulis japonicus	4.9	9.9~37.0	3/17	3.8	26.7~78.6	2/17
Sebastes schelegeli	1.0	1.5~8.2	6/17			
Sebastes vulpes	0.2	6.6	1/17			
Liparis Sp.	0.2	2.6	1/17			
Limanda herzenstein	0.4	8.6	1/17			
Lophius litulon	0.1	3.3	1/17			
unidentified sp.	0.1	3.3	1/17	214.4	1.2~4,372	7/17

- Growth parameters for commercially important 10 species

Table 12. Growth parameters for commercially important 10 species

Species		Growth Pattern					References
Common Name	Scientific Name	L_∞ (cm)	k	t_0	$W=aL^b$	Longevity (in year)	
small yellow croaker	*Larimichthys polyactis*	34.7	0.376	-0.609	$0.004298\ TL^{3.227}$	10	NFRDI, 2005
		36.2	0.332	-0.593	$0.0196\ TL^{2.802}$	NA	Hwang and Choi, 1980
Spanish mackerel	*Scomberomorus niphonius*	123.3	0.196	-2.140	$6.577\ FL^{3.002}x10^{-6}$	8	NFRDI, 2005
anchovy	*Engraulis japonicus*	NA	0.38mm/day	0.37	NA	1	Cha, 1990
chub mackerel	*Scomber japonicus*	40.2	0.403	-0.718	$0.0056\ FL^{3.2537}$	6	NFRDI, 2005
		51.7	0.299	-0.428	$0.00044\ FL^{3.332}$	6	Choi et al., 2000
		40.2	0.408	-0.719	$1.756\ FL^{3.342}x10^{-6}$	NA	Ahn, 1971
largehead hairtail	*Trichiurus lepturus*	45.6	0.408	0.440	$0.06321\ AL^{2.5456}$	9	NFRDI, 2005
		50.5	0.162	-1.722	$0.0323\ AL^{2.7826}$	NA	Park et al., 1996
		52.3	0.154	-1.496	NA	NA	Park et al., 2000
Pacific herring	*Clupea pallasii*	NA	NA	NA	NA	NA	-
sandlance	*Ammodytes personatus*	NA	NA	NA	NA	NA	-
acetes	*Acetes chinensis* and *A. japonicus*	F:13.5	0.69	0	$0.004\ TL^{3.1692}$	NA	Oh and Jeong, 2002
		M:10.4	0.84	0	$0.007\ TL^{2.9407}$		
fleshy prown	*Fenneropenaeus chinensis*	F: 20.1	0.018	25 days	$0.0000111\ BL^{3.002}$	360 days	NFRDI, 2005
		M: 16.4	0.017	9 days			
common squids	*Todarodes pacificus*	27.4~31.4	0.147~0.189	NA	$0.0091\ ML^{3.2472}$	1	NFRDI, 2005

NA represents No data Available.

- Biological data

Table 13. Reproduction and spawning characteristics of commercially important 10 species

Species		Reproduction				References
Common Name	Scientific Name	Fecundity (× 10,000)	Optimum temp. (℃)	Min. length at maturity (cm)	Season	
small yellow croaker	*Larimichthys polyactis*	3~10	12~14	19.1	Apr.~Jun	NFRDI, 2005
Spanish mackerel	*Scomberomorus niphonius*	50~90	16~18	78	Apr.~Jun	NFRDI, 2005
		NA	16~21	NA	late June.~late Aug.	Hwang et al., 1977
anchovy	*Engraulis japonicus*	2.3~31.5	15~20	NA	Mar.~Aug. Mar.~Oct. Mar.~Aug.	Kim and Kang, 1992 Lim et al., 1970 Choi and Kim, 1988 Cha, 1990
chub mackerel	*Scomber japonicus*	30~140	17~18	27.0(FL)	Jan.~Mar.	NFRDI, 2005
		11~57	NA	28.7(FL)	Mar.~Jun.	Cha et al., 2002
largehead hairtail	*Trichiurus lepturus*	2~8.5	18~20	25.7(AL)	May~Aug. (Jul.)	NFRDI, 2005
		1.5~23	NA	22.5(AL)	May~Sep. (Jun)	Park et al., 1998
		NA	NA	25.6(AL)	May~Sep.	Cha et al., 2004
Pacific herring	*Clupea pallasii*	NA	NA	NA	NA	-
sandlance	*Ammodytes personatus*	NA	NA	NA	NA	-
acetes	*Acetes chinensis* and *A. japonicus*	NA	18	4.08(TL)	Jun.~Sep.(Jul.~Sep.)	Oh and Jeong, 2002
fleshy prown	*Fenneropenaeus chinensis*	20~120	16	F: 19.6(BL) M: 14.8(BL)	Apr.~Jun. (May)	NFRDI, 2005
common squids	*Todarodes pacificus*	30~50	10~21	20(ML)	Winter : Jan.~Mar. Summer : Jun.~Aug. Autumn : Sep.~Nov.	NFRDI, 2005

NA represents No data Available.

11.2.2 Collected data and information on Socio-economic

- Fishing vessels by fishery

Table 14. Number and gross tonnage of fishing vessels and tons by fishery from 2000 to 2004

(unit: vessels, ton)

		2000	2001	2002	2003	2004
Total	Number	95,890	94,935	94,388	93,257	91,608
	Power Vessel	89,294	89,347	89,327	88,521	87,203
	Non-power Vessel	6,596	5,588	5,061	4,736	4,405
	GT	923,099	884,853	816,563	754,439	724,980
	Power Vessel	917,963	880,467	812,629	750,763	721,398
	Non-power Vessel	5,136	4,386	3,934	3,676	3,582
Distant Waters Fisheries	Number	597	568	543	517	491
	GT	349,420	335,552	318,855	273,086	261,237
Off-shore, Coastal Fisheries	Number	68,629	67,990	67,411	66,698	66,063
	GT	397,868	386,181	362,163	344,992	330,203

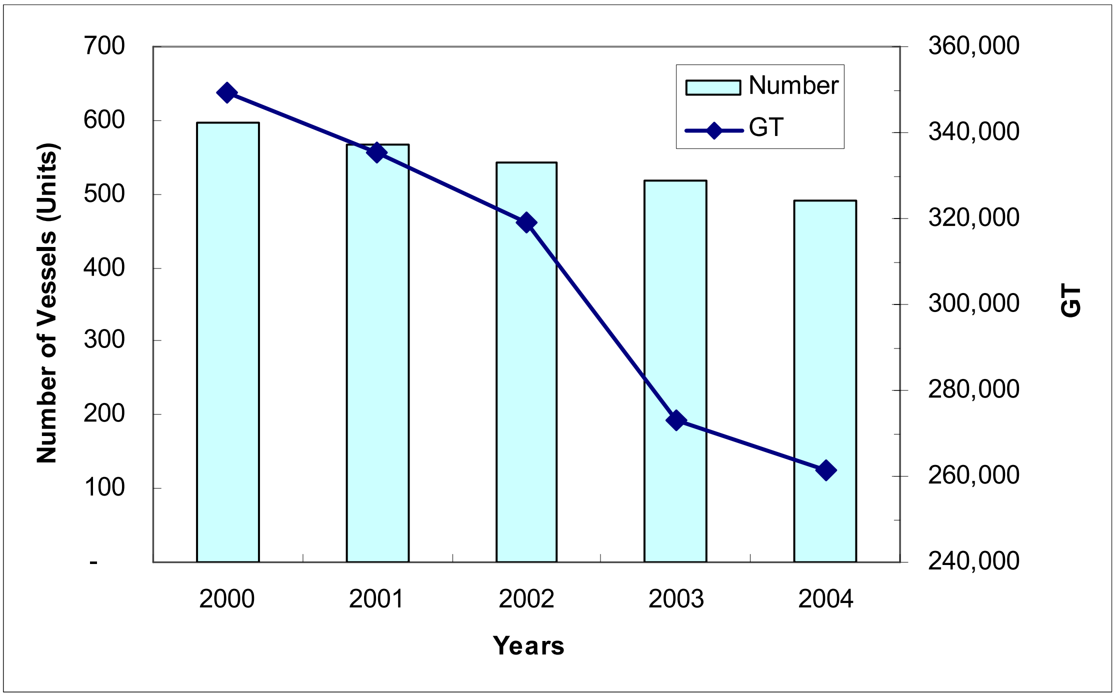


Figure 22. Fluctuation of fishing vessel number and GT in the distance water fisheries.

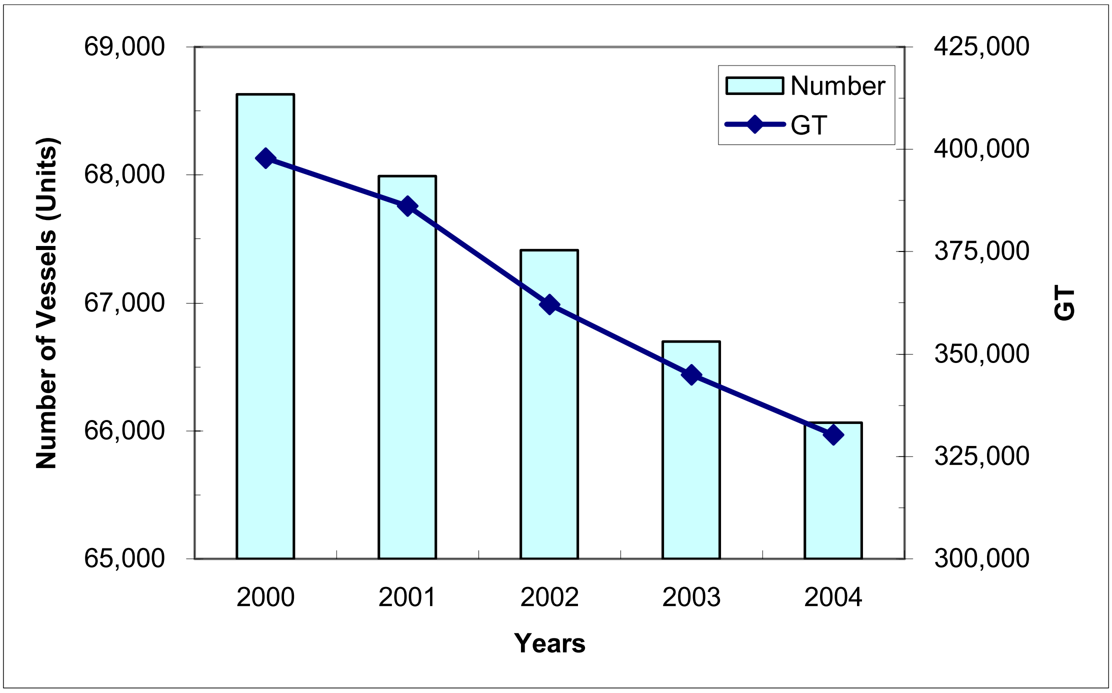


Figure 23. Fluctuation of fishing vessel number and GT in the off shore coastal fisheries.

- Vessels by province

Table 15. Total vessels and tons by provinces from 2000 to 2004

(unit: vessels, ton)

		2000	2001	2002	2003	2004
Incheon	Number	2,357	2,369	2,396	2,450	2,386
	GT	45,399	43,922	41,459	40,349	37,800
Gyeonggi	Number	2,202	2,196	2,209	2,335	2,336
	GT	3,440	3,489	3,819	4,301	4,648
Chungnam	Number	6,643	6,695	6,620	6,585	6,517
	GT	19,666	21,161	21,808	22,006	22,231
Jeonbuk	Number	4,979	4,936	4,844	4,792	4,652
	GT	27,772	26,164	20,268	18,504	16,803
Jeonnam	Number	35,820	36,303	36,628	36,834	36,095
	GT	115,036	110,884	108,997	103,309	101,646

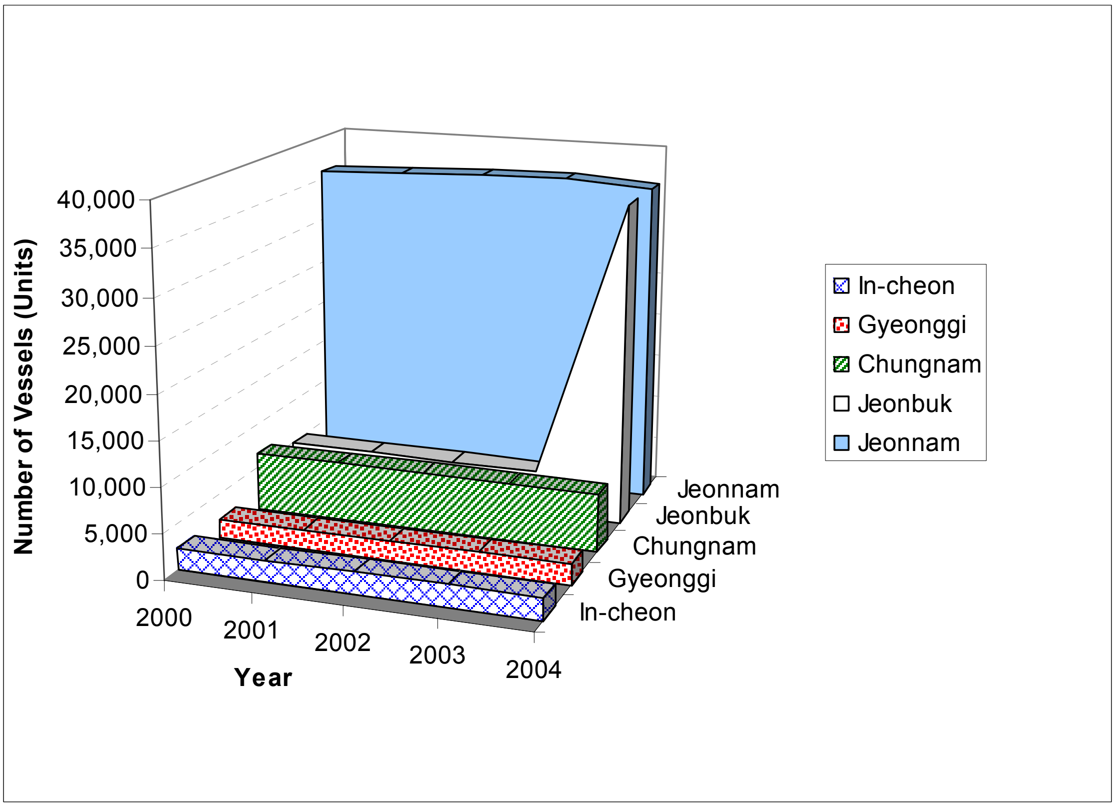


Figure 24. Distribution of fishing vessel number in the Yellow Sea areas of Korean provinces.

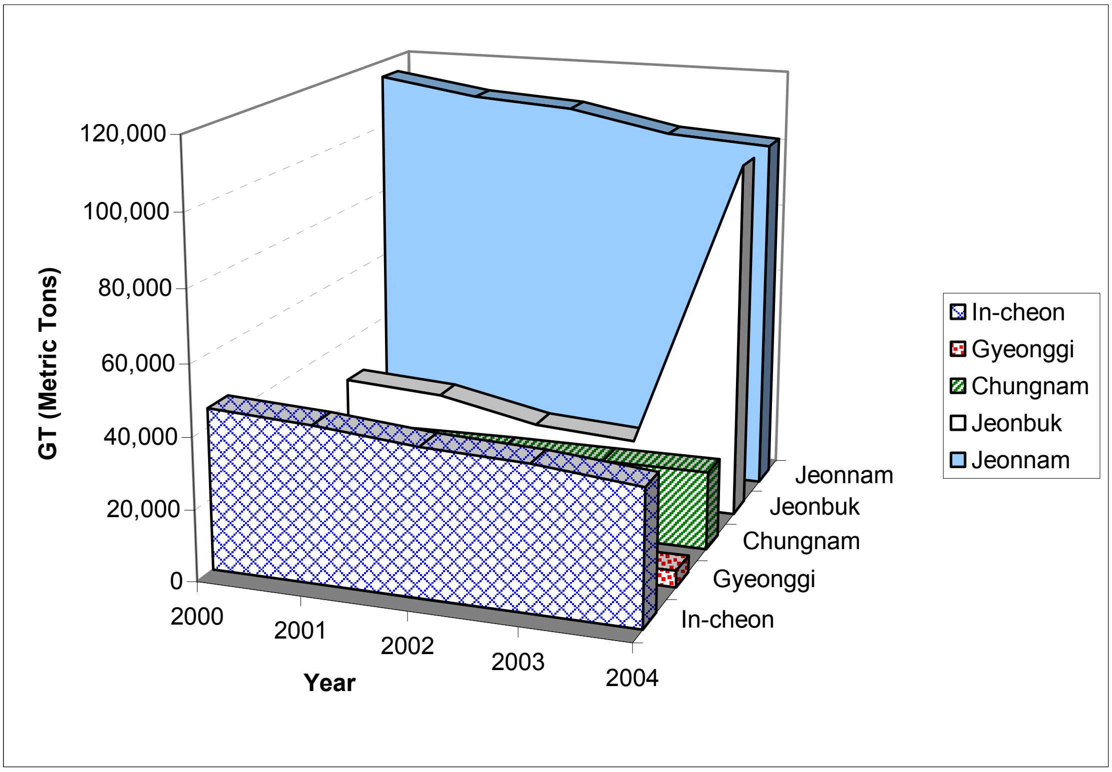


Figure 25. Distribution of GTs in the Yellow Sea areas of Korean provinces.

- Number of fishermen by province

Table 16. Number of fishermen by provinces from 2000 to 2004

(unit: 1,000 persons)

		2000	2001	2002	2003	2004
No. of Persons whole country		140	137	128	125	122
Province	Incheon	5	5	4	4	3
	Gyeonggi	3	3	3	3	3
	Chungnam	17	17	17	17	16
	Jeonbuk	8	9	7	7	7
	Jeonnam	52	51	46	45	45

Source: National Statistical Office, 「Basic Statical Research in Korean Fisheries」

- Fisheries income

Table 17. Fisheries incomes from 2000 to 2004 (unit: 1,000 won)

	2000	2001	2002	2003	2004
Fisheries Income	10,078	11,087	10,165	10,741	11,959

- Fisheries consumption per capita (kg)

Table 18. Fisheries consumption per capita from 2000 to 2004 (unit: kg/year)

	2000	2001	2002	2003	2004
Total	36.8	42.9	44.5	44.7	NA

NA: No data Available.

- Exports and imports of fishery products

Table 19. The exports and imports of fishery products form 2000 to 2004 (unit: 1,000$)

	2000	2001	2002	2003	2004
Exports	1,504,470	1,273,619	1,160,435	1,129,385	1,278,638
Imports	1,410,598	1,648,372	1,884,417	1,961,145	2,261,356

- Economic importance of fisheries (GDP Contribution)

Table 20. The GDP contribution of fishery products form 2000 to 2004 (unit: thousand million won, %)

	2000	2001	2002	2003	2004
GDP	578,664	600,866	642,748	662,655	693,424
Fisheries	2,155	2,164	2,000	2,006	1,966
GDP Contribution	0.4	0.4	0.3	0.3	0.3

Source: The Bank of Korea, Economy Statics System

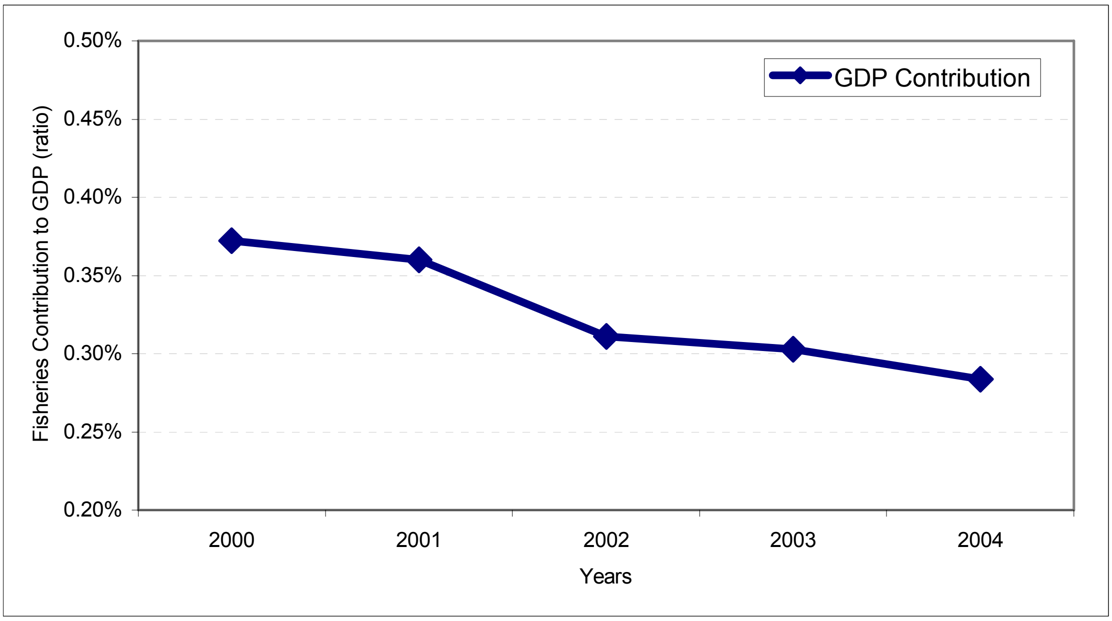


Figure 26. Variation of fisheries GDP contribution to total GDP of Korea.

11.2.3 Collected data and information on mariculture

- Annual total production of marine farmed organisms from 1995 to 2004

Table 21. Total production of marine farmed organisms in 1995

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	96		1	3	280.3	380.3
	Lateolabrax spp.		9	30	-	3.0	42.0
	Epinephelus septemfasciatus					0.3	0.3
	Acanthopagrus schlegelii					2.3	2.3
	Oplegnathus fasciatus			2		-	2.0
	Pagrus major					0.3	0.3
	Other sea breams				-	0.5	0.5
	Miichthys miiuy					-	-
	Sciaenops ocellatus					-	-
	Seriola quinqueradiata					2.8	2.8
	Takifugu spp.					-	-
	Sebastes schlegeli	3		66	-	42.8	111.8
	Other rock fishes			132	4	0.3	136.3
	Muguil spp.		23		-	2.8	25.8
	Pleurogrammus azonus			14		-	14.0
	Konosirus punctatus				-	-	-
	Stephanolepis sp.,*Thamnaconus* sp.					-	-
	Other finfishes					-	-
	subtotal	99	32	245	7	335.0	718.0
Crustaceans	*Fenneropenaeus chinensis*	24	24	289	1	14.8	352.8
	Marsupenaeus japonicus			25		0.3	25.3
	subtotal	24	24	314	1	15.1	378.1
Shellfish	*Crassostrea gigas*	2,809		9,315		5,128.3	17,252.3
	Rapana venosa					-	-
	Haliotis discus hannai	6		44	1	2.5	53.5
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis				-	16.3	16.3
	Mactra chinensis					-	-
	Scapharca subcrenata	6			-	2,917.3	2,923.3
	Solen spp.				-	1,792.3	1,792.3
	Ruditapes philippinarum			5,992	99	1,238.5	7,329.5
	Meretrix lusoria				39	-	39.0
	Atrina pectinata					-	-
	Scapharca broughtonii					93.3	93.3
	Mactra veneriformis				476		476.0
	Mytilus spp.					7,301.8	7,301.8
	Other shellfish				4	-	4.0
	subtotal	2,821	-	15,351	619	18,490.1	37,281.1
Seaweeds	*Porphyra* spp.	1,307	1,136	14,035	16,132	35,147.5	67,757.5
	Laminaria japonica					5,733.8	5,733.8
	Undaria pinnatifida					93,658.3	93,658.3
	Gelidium amansii					-	-
	Gigartina spp.					-	-
	Codium fragile					-	-
	Hizikia fusiforme					9,419.8	9,419.8
	Enteromorpha spp.					817.3	817.3
	Other seaweed					-	-
	subtotal	1,307	1,136	14,035	16,132	144,776.5	177,386.5
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus					-	-
	subtotal	-	-			-	-
total(mt)		4,251	1,192	29,945	16,759	163,616.7	215,763.7

Table 22. Total production of marine farmed organisms in 1996

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	106		117	-	604.0	827.0
	Lateolabrax spp.		6		-	4.3	10.3
	Epinephelus septemfasciatus			2		-	2.0
	Acanthopagrus schlegelii					0.5	0.5
	Oplegnathus fasciatus			1		-	1.0
	Pagrus major					-	-
	Other sea breams				-	-	-
	Miichthys miiuy					-	-
	Sciaenops ocellatus					-	-
	Seriola quinqueradiata					0.3	0.3
	Takifugu spp.					-	-
	Sebastes schlegeli	1		341	-	39.0	381.0
	Other rock fishes			7	-	4.0	11.0
	Muguil spp.		9		-	4.5	13.5
	Pleurogrammus azonus			19		-	19.0
	Konosirus punctatus				-	-	-
	Stephanolepis sp.; *Thamnaconus* sp.					-	-
	Other finfishes					-	-
	subtotal	107	15	487	-	656.5	1,265.5
Crustaceans	*Fenneropenaeus chinensis*	139	54	133	-	12.8	338.8
	Marsupenaeus japonicus					1.3	1.3
	subtotal	139	54	133	-	14.1	340.1
Shellfish	*Crassostrea gigas*			8,865		4,844.3	13,709.3
	Rapana venosa					-	-
	Haliotis discus hannai	2		21	-	1.5	24.5
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis				-	6.8	6.8
	Mactra chinensis					-	-
	Scapharca subcrenata				-	741.5	741.5
	Solen spp.				-	1,710.8	1,710.8
	Ruditapes philippinarum			7,624	92	1,038.5	8,754.5
	Meretrix lusoria				17	-	17.0
	Atrina pectinata					-	-
	Scapharca broughtonii					65.0	65.0
	Mactra veneriformis				178		178.0
	Mytilus spp.					9,840.3	9,840.3
	Other shellfish				-	-	-
	subtotal	2	-	16,510	287	18,248.6	35,047.6
Seaweeds	*Porphyra* spp.	1,270		9,612	9,764	34,422.3	55,068.3
	Laminaria japonica					8,066.0	8,066.0
	Undaria pinnatifida					73,614.0	73,614.0
	Gelidium amansii					-	-
	Gigartina spp.					-	-
	Codium fragile					-	-
	Hizikia fusiforme					5,763.5	5,763.5
	Enteromorpha spp.					628.3	628.3
	Other seaweed					1.0	1.0
	subtotal	1,270	-	9,612	9,764	122,495.0	143,141.0
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus					-	-
	subtotal	-	-			-	-
total(mt)		1,518	69	26,742	10,051	141,414.2	179,794.2

Table 23. Total production of marine farmed organisms in 1997

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	108		138	-	2,428.3	2,674.3
	Lateolabrax spp.		1		-	13.8	14.8
	Epinephelus septemfasciatus					0.5	0.5
	Acanthopagrus schlegelii			10		-	10.0
	Oplegnathus fasciatus			9		-	9.0
	Pagrus major					4.8	4.8
	Other sea breams				-	-	-
	Miichthys miiuy					-	-
	Sciaenops ocellatus					-	-
	Seriola quinqueradiata					0.8	0.8
	Takifugu spp.					-	-
	Sebastes schlegeli	1	201	789	-	773.5	1,764.5
	Other rock fishes				-	1.8	1.8
	Muguil spp.		8		-	43.0	51.0
	Pleurogrammus azonus			2		-	2.0
	Konosirus punctatus				-	-	-
	Stephanolepis sp.; *Thamnaconus* sp.					-	-
	Other finfishes			3		-	3.0
	subtotal	109	210	951	-	3,266.3	4,536.3
Crustaceans	*Fenneropenaeus chinensis*	600	430	324	107	18.0	1,479.0
	Marsupenaeus japonicus					-	-
	subtotal	600	430	324	107	18.0	1,479.0
Shellfish	*Crassostrea gigas*			5,031		5,494.3	10,525.3
	Rapana venosa					-	-
	Haliotis discus hannai	4		1	1	0.3	6.3
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis				-	-	-
	Mactra chinensis					-	-
	Scapharca subcrenata				-	384.5	384.5
	Solen spp.				-	1,645.0	1,645.0
	Ruditapes philippinarum			7,703	-	739.8	8,442.8
	Meretrix lusoria				-	-	-
	Atrina pectinata				-	-	-
	Scapharca broughtonii					15.3	15.3
	Mactra veneriformis						-
	Mytilus spp.					8,853.0	8,853.0
	Other shellfish				-	-	-
	subtotal	4	-	12,735	1	17,132.0	29,872.0
Seaweeds	*Porphyra* spp.	446	129	9,964	9,999	27,043.5	47,581.5
	Laminaria japonica					7,762.0	7,762.0
	Undaria pinnatifida					105,898.5	105,898.5
	Gelidium amansii					-	-
	Gigartina spp.					-	-
	Codium fragile					-	-
	Hizikia fusiforme					8,617.5	8,617.5
	Enteromorpha spp.					882.3	882.3
	Other seaweed					-	-
	subtotal	446	129	9,964	9,999	150,203.8	170,741.8
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus	-	-	-	-	-	-
	subtotal	-	-	-	-	-	-
total(mt)		1,159	769	23,974	10,107	170,620.0	206,629.0

Table 24. Total production of marine farmed organisms in 1998

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	10		55	-	1,763.8	1,828.8
	Lateolabrax spp.				-	38.5	38.5
	Epinephelus septemfasciatus					-	-
	Acanthopagrus schlegelii			36		0.5	36.5
	Oplegnathus fasciatus			19		-	19.0
	Pagrus major					3.3	3.3
	Other sea breams				-	10.3	10.3
	Miichthys miiuy					-	-
	Sciaenops ocellatus					-	-
	Seriola quinqueradiata					0.3	0.3
	Takifugu spp.					-	-
	Sebastes schlegeli			989	-	1,348.0	2,337.0
	Other rock fishes				-	7.8	7.8
	Muguil spp.		9	37	-	6.8	52.8
	Pleurogrammus azonus					-	-
	Konosirus punctatus				-	-	-
	Stephanolepis sp. *Thamnaconus* sp.					-	-
	Other finfishes			3		-	3.0
	subtotal	10	9	1,139	-	3,179.0	4,337.0
Crustaceans	*Fenneropenaeus chinensis*	92	322	288	-	35.3	737.3
	Marsupenaeus japonicus						-
	subtotal	92	322	288	-	35.3	737.3
Shellfish	*Crassostrea gigas*	9		6,510		2,281.8	8,800.8
	Rapana venosa					-	-
	Haliotis discus hannai				-	0.3	0.3
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis			24	9	-	33.0
	Mactra chinensis					-	-
	Scapharca subcrenata				-	1,086.0	1,086.0
	Solen spp.				13	13.8	26.8
	Ruditapes philippinarum			7,022	4,616	795.8	12,433.8
	Meretrix lusoria				-	-	-
	Atrina pectinata					47.5	47.5
	Scapharca broughtonii					0.5	0.5
	Mactra veneriformis						-
	Mytilus spp.					1,438.3	1,438.3
	Other shellfish				-	-	-
	subtotal	9	-	13,556	4,638	5,663.8	23,866.8
Seaweeds	*Porphyra* spp.	1,080	826	13,949	16,465	38,244.8	70,564.8
	Laminaria japonica					1,644.8	1,644.8
	Undaria pinnatifida					53,739.0	53,739.0
	Gelidium amansii					-	-
	Gigartina spp.					-	-
	Codium fragile					-	-
	Hizikia fusiforme					6,245.3	6,245.3
	Enteromorpha spp.					1,053.8	1,053.8
	Other seaweed					488.0	488.0
	subtotal	1,080	826	13,949	16,465	101,415.5	133,735.5
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus			5		-	5.0
	subtotal	-	-	5	-	-	5.0
total(mt)		1,191	1,157	28,937	21,103	110,293.6	162,681.6

Table 25. Total production of marine farmed organisms in 1999

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	153		67	-	1,305.5	1,525.5
	Lateolabrax spp.				-	22.5	22.5
	Epinephelus septemfasciatus					1.0	1.0
	Acanthopagrus schlegelii			62		3.8	65.8
	Oplegnathus fasciatus			106		-	106.0
	Pagrus major					17.0	17.0
	Other sea breams				-	8.0	8.0
	Miichthys miiuy					0.8	0.8
	Sciaenops ocellatus					-	-
	Seriola quinqueradiata					0.5	0.5
	Takifugu spp.					3.8	3.8
	Sebastes schlegeli			798	-	802.3	1,600.3
	Other rock fishes				-	148.5	148.5
	Muguil spp.			24	-	48.3	72.3
	Pleurogrammus azonus					-	-
	Konosirus punctatus				-	-	-
	Stephanolepis sp.; *Thamnaconus* sp.					0.8	0.8
	Other finfishes					-	-
	subtotal	153	-	1,057	-	2,362.5	3,572.5
Crustaceans	*Fenneropenaeus chinensis*	182	226	433	8	66.5	915.5
	Marsupenaeus japonicus					-	-
	subtotal	182	226	433	8	66.5	915.5
Shellfish	*Crassostrea gigas*			8,552		3,645.0	12,197.0
	Rapana venosa					-	-
	Haliotis discus hannai				-	-	-
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis			3	-	-	3.0
	Mactra chinensis					-	-
	Scapharca subcrenata				-	362.5	362.5
	Solen spp.				-	-	-
	Ruditapes philippinarum			6,664	4,175	665.5	11,504.5
	Meretrix lusoria				-	-	-
	Atrina pectinata					276.0	276.0
	Scapharca broughtonii					-	-
	Mactra veneriformis						-
	Mytilus spp.					1,886.8	1,886.8
	Other shellfish				-	2.5	2.5
	subtotal	-	-	15,219	4,175	6,838.3	26,232.3
Seaweeds	*Porphyra* spp.	967	1,398	9,082	19,250	40,314.3	71,011.3
	Laminaria japonica					5,315.5	5,315.5
	Undaria pinnatifida			15		45,972.5	45,987.5
	Gelidium amansii					4.0	4.0
	Gigartina spp.					0.5	0.5
	Codium fragile					-	-
	Hizikia fusiforme					5,665.8	5,665.8
	Enteromorpha spp.					1,201.5	1,201.5
	Other seaweed					48.3	48.3
	subtotal	967	1,398	9,097	19,250	98,522.3	129,234.3
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus			2		-	2.0
	subtotal	-	-	2	-	-	2.0
total(mt)		1,302	1,624	25,808	23,433	107,789.6	159,956.6

Table 26. Total production of marine farmed organisms in 2000

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	124		14	-	728.8	866.8
	Lateolabrax spp.			2	-	32.8	34.8
	Epinephelus septemfasciatus					0.3	0.3
	Acanthopagrus schlegelii			55		22.5	77.5
	Oplegnathus fasciatus			87		-	87.0
	Pagrus major					16.0	16.0
	Other sea breams				-	13.5	13.5
	Miichthys miiuy			10		1.8	11.8
	Sciaenops ocellatus					-	-
	Seriola quinqueradiata					5.8	5.8
	Takifugu spp.					-	-
	Sebastes schlegeli			524	-	511.5	1,035.5
	Other rock fishes				-	22.3	22.3
	Muguil spp.	78		28	86	77.5	269.5
	Pleurogrammus azonus					-	-
	Konosirus punctatus				-	-	-
	Stephanolepis sp.; *Thamnaconus* sp.					1.8	1.8
	Other finfishes					-	-
	subtotal	202	-	720	86	1,434.3	2,442.3
Crustaceans	*Fenneropenaeus chinensis*	154	251	553	-	49.0	853.0
	Marsupenaeus japonicus					-	-
	subtotal	154	251	553	-	49.0	853.0
Shellfish	*Crassostrea gigas*	390		9,224		2,522.0	12,136.0
	Rapana venosa					2.3	2.3
	Haliotis discus hannai			1	-	1.8	2.8
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis			46	-	-	46.0
	Mactra chinensis					-	-
	Scapharca subcrenata				-	165.5	165.5
	Solen spp.				-	0.5	0.5
	Ruditapes philippinarum	56		8,538	3,490	854.5	12,938.5
	Meretrix lusoria				-	-	-
	Atrina pectinata					499.5	499.5
	Scapharca broughtonii					-	-
	Mactra veneriformis						-
	Mytilus spp.					1,200.0	1,200.0
	Other shellfish				3	0.5	3.5
	subtotal	446	-	17,809	3,493	5,246.5	26,994.5
Seaweeds	*Porphyra* spp.	637	550	5,306	17,125	23,113.8	46,094.8
	Laminaria japonica					3,322.5	3,322.5
	Undaria pinnatifida			5		45,402.5	45,407.5
	Gelidium amansii					-	-
	Gigartina spp.					-	-
	Codium fragile					-	-
	Hizikia fusiforme					2,912.3	2,912.3
	Enteromorpha spp.					1,050.8	1,050.8
	Other seaweed					68.3	68.3
	subtotal	637	550	5,311	17,125	75,870.0	98,856.0
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus			1		-	1.0
	subtotal	-	-	1		-	1.0
total(mt)		1,439	801	24,394	20,704	82,599.8	129,146.8

Table 27. Total production of marine farmed organisms in 2001

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	167		1	-	1,448.0	1,616.0
	Lateolabrax spp.	2			1	71.0	74.0
	Epinephelus septemfasciatus					3.3	3.3
	Acanthopagrus schlegelii			112		19.0	131.0
	Oplegnathus fasciatus			13		-	13.0
	Pagrus major					28.0	28.0
	Other sea breams				-	2.5	2.5
	Miichthys miiuy					4.3	4.3
	Sciaenops ocellatus					-	-
	Seriola quinqueradiata			3		0.3	3.3
	Takifugu spp.					-	-
	Sebastes schlegeli			482	-	819.8	1,301.8
	Other rock fishes				-	11.5	11.5
	Muguil spp.	93	30	64	4	26.5	124.5
	Pleurogrammus azonus					0.8	0.8
	Konosirus punctatus				-	-	-
	Stephanolepis sp.; *Thamnaconus* sp.					0.8	0.8
	Other finfishes			6		-	6.0
	subtotal	262	30	681	5	2,435.5	3,320.5
Crustaceans	*Fenneropenaeus chinensis*	154	280	659	30	239.5	1,208.5
	Marsupenaeus japonicus					-	-
	subtotal	154	280	659	30	239.5	1,208.5
Shellfish	*Crassostrea gigas*	221		8,344		2,051.3	10,616.3
	Rapana venosa					-	-
	Haliotis discus hannai				-	5.0	5.0
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis			25	-	-	25.0
	Mactra chinensis					1.5	1.5
	Scapharca subcrenata				-	932.5	932.5
	Solen spp.				-	-	-
	Ruditapes philippinarum	45		11,449	2,909	250.3	14,653.3
	Meretrix lusoria				-	-	-
	Atrina pectinata					309.0	309.0
	Scapharca broughtonii					-	-
	Mactra veneriformis						-
	Mytilus spp.					1,866.0	1,866.0
	Other shellfish				-	-	-
	subtotal	266	-	19,818	2,909	5,415.5	28,408.5
Seaweeds	*Porphyra* spp.	186	571	7,767	18,775	30,937.3	58,050.3
	Laminaria japonica					3,676.5	3,676.5
	Undaria pinnatifida			484		36,620.5	37,104.5
	Gelidium amansii					-	-
	Gigartina spp.					-	-
	Codium fragile					-	-
	Hizikia fusiforme					1,716.3	1,716.3
	Enteromorpha spp.					1,199.5	1,199.5
	Other seaweed					0.3	0.3
	subtotal	186	571	8,251	18,775	74,150.3	101,747.3
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus					-	-
	subtotal	-	-			-	-
total(mt)		868	881	29,409	21,719	82,240.8	134,684.8

Table 28. Total production of marine farmed organisms in 2002

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
	Paralichthys olivaceus	185			-	1,826.0	2,011.0
	Lateolabrax spp.			71	2	121.0	194.0
	Epinephelus septemfasciatus					7.8	7.8
	Acanthopagrus schlegelii			374		18.3	392.3
	Oplegnathus fasciatus			60		-	60.0
	Pagrus major					26.0	26.0
	Other sea breams				-	5.3	5.3
	Miichthys miiuy					1.0	1.0
	Sciaenops ocellatus					-	-
Finfish	*Seriola quinqueradiata*					6.8	6.8
	Takifugu spp.					0.5	0.5
	Sebastes schlegeli			768	4	1,579.0	2,351.0
	Other rock fishes				-	2.5	2.5
	Muguil spp.	24	44	271	225	271.0	835.0
	Pleurogrammus azonus					-	-
	Konosirus punctatus				-	-	-
	Stephanolepis sp.; *Thamnaconus* sp.					-	-
	Other finfishes			32		-	32.0
	subtotal	209	44	1,576	231	3,865.0	5,925.0
	Fenneropenaeus chinensis	68	38	961	-	83.0	1,150.0
Crustaceans	*Marsupenaeus japonicus*					-	-
	subtotal	68	38	961	-	83.0	1,150.0
	Crassostrea gigas	534		10,458		2,659.8	13,651.8
	Rapana venosa					-	-
	Haliotis discus hannai				-	14.8	14.8
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis	189		30	-	-	219.0
	Mactra chinensis					-	-
	Scapharca subcrenata				-	93.5	93.5
Shellfish	*Solen* spp.				-	-	-
	Ruditapes philippinarum	288		6,153	3,083	179.0	9,703.0
	Meretrix lusoria				-	1.0	1.0
	Atrina pectinata					144.3	144.3
	Scapharca broughtonii					-	-
	Mactra veneriformis						-
	Mytilus spp.					1,676.3	1,676.3
	Other shellfish				-	-	-
	subtotal	1,011	-	16,641	3,083	4,768.6	25,503.6
	Porphyra spp.	378	939	5,897	22,519	40,379.0	70,112.0
	Laminaria japonica					5,220.3	5,220.3
	Undaria pinnatifida			127		50,754.5	50,881.5
	Gelidium amansii					1.0	1.0
Seaweeds	*Gigartina* spp.					-	-
	Codium fragile					18.0	18.0
	Hizikia fusiforme					2,751.0	2,751.0
	Enteromorpha spp.					2,113.3	2,113.3
	Other seaweed					42.8	42.8
	subtotal	378	939	6,024	22,519	101,279.8	131,139.8
	Halocynthia roretzi					-	-
Others	*Stichopus japonicus*					-	-
	subtotal	-	-			-	-
total(mt)		1,666	1,021	25,202	25,833	109,996.3	163,718.3

Table 29. Total production of marine farmed organisms in 2003

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	49			-	2,419.8	2,468.8
	Lateolabrax spp.			45	-	145.5	190.5
	Epinephelus septemfasciatus					0.8	0.8
	Acanthopagrus schlegelii			309		39.0	348.0
	Oplegnathus fasciatus			400		-	400.0
	Pagrus major					26.8	26.8
	Other sea breams				-	14.5	14.5
	Miichthys miiuy					-	-
	Sciaenops ocellatus					-	-
	Seriola quinqueradiata					-	-
	Takifugu spp.					1.0	1.0
	Sebastes schlegeli		15	1,970	3	2,257.8	4,245.8
	Other rock fishes			23	-	4.3	27.3
	Muguil spp.	35	43	743	126	89.8	1,036.8
	Pleurogrammus azonus					-	-
	Konosirus punctatus				-	-	-
	Stephanolepis sp. *Thamnaconus* sp.					-	-
	Other finfishes	1		1		4.3	6.3
	subtotal	85	58	3,491	129	5,003.3	8,766.3
Crustaceans	*Fenneropenaeus chinensis*	76	19	519	59	411.0	1,084.0
	Marsupenaeus japonicus						-
	subtotal	76	19	519	59	411.0	1,084.0
Shellfish	*Crassostrea gigas*	432		7,461		18,505.0	26,398.0
	Rapana venosa					-	-
	Haliotis discus hannai				-	258.8	258.8
	Chlamys farreri nipponensis					-	-
	Cyclina sinensis	8		181	-	-	189.0
	Mactra chinensis					-	-
	Scapharca subcrenata			3	-	549.8	552.8
	Solen spp.				-	0.5	0.5
	Ruditapes philippinarum	544		15,551	9,233	133.5	25,461.5
	Meretrix lusoria			1	-	-	1.0
	Atrina pectinata					195.8	195.8
	Scapharca broughtonii					-	-
	Mactra veneriformis						-
	Mytilus spp.					901.3	901.3
	Other shellfish				-	-	-
	subtotal	984	-	23,197	9,233	20,544.6	53,958.6
Seaweeds	*Porphyra* spp.	443	3,843	10,144	16,762	36,525.8	67,717.8
	Laminaria japonica					5,988.5	5,988.5
	Undaria pinnatifida			980		41,557.3	42,537.3
	Gelidium amansii					-	-
	Gigartina spp.					-	-
	Codium fragile					-	-
	Hizikia fusiforme					8,412.0	8,412.0
	Enteromorpha spp.					116.3	116.3
	Other seaweed					-	-
	subtotal	443	3,843	11,124	16,762	92,599.8	124,771.8
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus					-	-
	subtotal	-	-			-	-
total(mt)		1,588	3,920	38,331	26,183	118,558.6	188,580.6

Table 30. Total production of marine farmed organisms in 2004

(unit: M/T)

Kind	species	Province					TOTAL
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	
Finfish	*Paralichthys olivaceus*	65			8	2,243.5	2,316.5
	Lateolabrax spp.			28	7	91.3	126.3
	Epinephelus septemfasciatus				-	2.0	2.0
	Acanthopagrus schlegelii			191	-	31.3	222.3
	Oplegnathus fasciatus			343	-	-	343.0
	Pagrus major				-	29.3	29.3
	Other sea breams				-	73.0	73.0
	Miichthys miiuy				-	-	-
	Sciaenops ocellatus				-	-	-
	Seriola quinqueradiata				-	0.3	0.3
	Takifugu spp.			3		2.3	5.3
	Sebastes schlegeli		54	2,094	7	1,657.8	3,812.8
	Other rock fishes				-	3.0	3.0
	Muguil spp.	26	106	483	271	83.8	969.8
	Pleurogrammus azonus					-	-
	Konosirus punctatus	5			104	18.0	127.0
	Stephanolepis sp.*Thamnaconus* sp.			16		-	16.0
	Other finfishes	3				-	3.0
	subtotal	99	160	3,158	397	4,235.3	8,049.3
Crustaceans	*Fenneropenaeus chinensis*	36	26	637	81	399.0	1,179.0
	Marsupenaeus japonicus					-	-
	subtotal	36	26	637	81	399.0	1,179.0
Shellfish	*Crassostrea gigas*	1,004		9,933		12,542.8	23,479.8
	Rapana venosa					-	-
	Haliotis discus hannai				-	306.5	306.5
	Chlamys farreri nipponensis					0.3	0.3
	Cyclina sinensis			79	-	-	79.0
	Mactra chinensis					-	-
	Scapharca subcrenata				-	2,695.3	2,695.3
	Solen spp.				-	-	-
	Ruditapes philippinarum	29		14,889	10,096	204.0	25,218.0
	Meretrix lusoria				-	-	-
	Atrina pectinata					499.3	499.3
	Scapharca broughtonii					-	-
	Mactra veneriformis						-
	Mytilus spp.					813.0	813.0
	Other shellfish				-	-	-
	subtotal	1,033	-	24,901	10,096	17,061.0	53,091.0
Seaweeds	*Porphyra* spp.	344	3,688	14,684	15,731	45,744.0	80,191.0
	Laminaria japonica					5,293.3	5,293.3
	Undaria pinnatifida			335		54,351.5	54,686.5
	Gelidium amansii					-	-
	Gigartina spp.					-	-
	Codium fragile					9.5	9.5
	Hizikia fusiforme					5,702.8	5,702.8
	Enteromorpha spp.					12.5	12.5
	Other seaweed					-	-
	subtotal	344	3,688	15,019	15,731	111,113.5	145,895.5
Others	*Halocynthia roretzi*					-	-
	Stichopus japonicus					-	-
	subtotal	-	-	-	-	-	-
total(mt)		1,512	3,874	43,715	26,305	132,808.8	208,214.8

- Changes in total production of marine farmed organisms for last 10 years

Table 31. Changes of total production of marine farmed organisms from 1995 to 2004

(unit: M/T)

kind	species	1995		1996		1997		1998		1999		2000	
		YS	Total	YS	Total	YS	Total	YS	Total	YS	Total	YS	Total
Finfish	*Paralichthys olivaceus*	380.3	6733.0	827.0	8861.0	2674.3	26274.0	1828.8	22277.0	1525.5	21368.0	866.8	14127.0
	Lateolabrax spp.	42.0	193.0	10.3	266.0	14.8	703.0	38.5	940.0	22.5	797.0	34.8	605.0
	Epinephelus septemfasciatus	0.0	2.0	2.0	9.0	0.5	5.0	0.0	1.0	1.0	5.0	0.3	6.0
	Acanthopagrus schlegelii	2.3	9.0	0.5	2.0	10.0	12.0	36.5	51.0	65.8	92.0	77.5	221.0
	Oplegnathus fasciatus	2.0	0.0	1.0	0.0	9.0	0.0	19.0	0.0	106.0	0.0	87.0	0.0
	Pagrus major	0.0	25.0	0.0	27.0	4.8	115.0	3.3	146.0	17.0	176.0	16.0	412.0
	Other sea breams	0.5	16.0	0.0	14.0	0.0	30.0	10.3	134.0	8.0	186.0	13.5	386.0
	Miichthys miiuy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	16.0	11.8	51.0
	Sciaenops ocellatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Seriola quinqueradiata	2.8	159.0	0.0	116.0	0.8	302.0	0.0	266.0	0.5	236.0	5.8	494.0
	Takifugu spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	15.0	0.0	2.0
	Sebastes schlegeli	111.8	985.0	381.0	1922.0	1764.5	11069.0	2337.0	12544.0	1600.3	9459.0	1035.5	8473.0
	Other rock fishes	136.3	174.0	11.0	114.0	1.8	245.0	7.8	231.0	148.5	721.0	22.3	225.0
	Muguil spp.	25.8	34.0	13.5	27.0	51.0	201.0	52.8	106.0	72.3	347.0	269.5	968.0
	Pleurogrammus azonus	14.0	14.0	19.0	19.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
	Konosirus punctatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Stephanolepis sp.; *Thamnaconus* s	0.0	0.0	0.0	7.0	0.0	126.0	0.0	619.0	0.8	35.0	1.8	9.0
	Other finfish	0.0	16.0	0.0	18.0	3.0	37.0	3.0	8.0	0.0	0.0	0.0	7.0
	subtotal	**718.0**	**8360.0**	**1265.5**	**11402.0**	**4536.3**	**39121.0**	**4337.0**	**37323.0**	**3572.5**	**33453.0**	**2442.3**	**25986.0**
Crusta-ceans	*Fenneropenaeus chinensis*	352.8	404.0	338.8	377.0	1479.0	1533.0	737.3	846.0	915.5	1142.0	853.0	1158.0
	Marsupenaeus japonicus	25.3	34.0	1.3	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	other crustacean	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	38.0	0.0	0.0
	subtotal	**378.1**	**438.0**	**340.1**	**382.0**	**1479.0**	**1537.0**	**737.3**	**846.0**	**915.5**	**1180.0**	**853.0**	**1158.0**
Shellfish	*Crassostrea gigas*	17252.3	191156.0	13709.3	185339.0	10525.3	200973.0	8800.8	175926.0	12197.0	177259.0	12136.0	177079.0
	Rapana venosa	0.0	87.0	0.0	20.0	0.0	33.0	0.0	1.0	0.0	1.0	2.3	9.0
	Haliotis discus hannai	53.5	61.0	24.5	84.0	6.3	7.0	0.3	3.0	0.0	377.0	2.8	20.0
	Chlamys farreri nipponensis	0.0	59.0	0.0	102.0	0.0	637.0	0.0	360.0	0.0	3.0	0.0	2371.0
	Cyclina sinensis	16.3	66.0	6.8	27.0	0.0	5.0	33.0	33.0	3.0	2.0	46.0	46.0
	Mactra chinensis	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	2511.0	0.0	1.0
	Scapharca subcrenata	2923.3	13027.0	741.5	4473.0	384.5	2843.0	1086.0	5041.0	362.5	0.0	165.5	820.0
	Solen spp.	1792.3	7169.0	1710.8	6843.0	1645.0	6585.0	26.8	68.0	0.0	16135.0	0.5	0.0
	Ruditapes philippinarum	7329.5	15260.0	8754.5	18478.0	8442.8	13958.0	12433.8	17178.0	11504.5	17.0	12938.5	17927.0
	Meretrix lusoria	39.0	122.0	17.0	47.0	0.0	47.0	0.0	0.0	0.0	1104.0	0.0	0.0
	Atrina pectinata	0.0	51.0	0.0	3.0	0.0	22.0	47.5	190.0	276.0		499.5	1998.0
	Scapharca broughtonii	93.3	9357.0	65.0	20166.0	15.3	13156.0	0.5	23029.0	0.0	8550.0	0.0	10618.0
	Mactra veneriformis	476.0	478.0	178.0	183.0	0.0	19.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mytilus spp.	7301.8	75353.0	9840.3	70058.0	8853.0	63572.0	1438.3	17785.0	1886.8	15042.0	1200.0	11713.0
	Other shellfish	4.0	6.0	0.0	915.0	0.0	15.0	0.0	140.0	2.5	30.0	3.5	6.0
	subtotal	**37281.1**	**312252.0**	**35047.6**	**306738.0**	**29872.0**	**301873.0**	**23866.8**	**239754.0**	**26232.3**	**221031.0**	**26994.5**	**222608.0**
Seaweeds	*Porphyra* spp.	67757.5	192960.0	55068.3	166199.0	47581.5	140236.0	70564.8	191578.0	71011.3	205706.0	46094.8	130488.0
	Laminaria japonica	5733.8	27295.0	8066.0	35640.0	7762.0	33466.0	1644.8	7931.0	5315.5	25447.0	3322.5	14160.0
	Undaria pinnatifida	93658.3	386819.0	73614.0	305813.0	105898.5	431872.0	53739.0	239742.0	45987.5	213706.0	45407.5	212429.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	16.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.0	0.0	0.0
	Codium fragile	0.0	2.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	43.0	0.0	164.0
	Hizikia fusiforme	9419.8	37679.0	5763.5	23054.0	8617.5	34470.0	6245.3	24993.0	5665.8	22679.0	2912.3	11654.0
	Enteromorpha spp.	817.3	4344.0	628.3	8272.0	882.3	7794.0	1053.8	5298.0	1201.5	5873.0	1050.8	5288.0
	Other seaweeds	0.0	0.0	1.0	4.0	0.0	5.0	488.0	227.0	48.3	200.0	68.3	273.0
	subtotal	**177386.5**	**649099.0**	**143141.0**	**538990.0**	**170741.8**	**647843.0**	**133735.5**	**469769.0**	**129234.3**	**473672.0**	**98856.0**	**374456.0**
Others	*Halocynthia roretzi*	0.0	22626.0	0.0	13093.0	0.0	22318.0	0.0	8177.0	0.0	11845.0	0.0	2336.0
	Stichopus japonicus	0.0	1.0	0.0	0.0	0.0	0.0	5.0	0.0	2.0	0.0	1.0	0.0
	others	0.0	3675.0	0.0	4205.0	0.0	2442.0	0.0	21361.0	0.0	24071.0	0.0	26829.0
	subtotal	**0.0**	**26302.0**	**0.0**	**17298.0**	**0.0**	**24760.0**	**5.0**	**29538.0**	**2.0**	**35916.0**	**1.0**	**29165.0**
total		**215763.7**	**996451.0**	**179794.2**	**874810.0**	**206629.0**	**1015134.0**	**162681.6**	**777230.0**	**159956.6**	**765252.0**	**129146.8**	**653373.0**

Table 31. Continued

kind	species	2001		2002		2003		2004		total (Yellow Sea)	total
		YS	Total	YS	Total	YS	Total	YS	Total		
Finfish	*Paralichthys olivaceus*	1616.0	16426.0	2011.0	23348.0	2468.8	34533.0	2316.5	32141.0	16514.8	206088.0
	Lateolabrax spp.	74.0	873.0	194.0	2006.0	190.5	2778.0	126.3	1850.0	747.5	11011.0
	Epinephelus septemfasciatus	3.3	20.0	7.8	39.0	0.8	101.0	2.0	36.0	17.8	224.0
	Acanthopagrus schlegelii	131.0	275.0	392.3	685.0	348.0	1084.0	222.3	1379.0	1286.0	3810.0
	Oplegnathus fasciatus	13.0	0.0	60.0	0.0	400.0	0.0	343.0	0.0	1040.0	0.0
	Pagrus major	28.0	641.0	26.0	960.0	26.8	4417.0	29.3	3988.0	151.3	10907.0
	Other sea breams	2.5	94.0	5.3	234.0	14.5	1287.0	73.0	1430.0	127.5	3811.0
	Miichthys miiuy	4.3	45.0	1.0	19.0	0.0	7.0	0.0	0.0	17.8	138.0
	Sciaenops ocellatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Seriola quinqueradiata	3.3	95.0	6.8	186.0	0.0	114.0	0.3	45.0	20.5	2013.0
	Takifugu spp.	0.0	63.0	0.5	29.0	1.0	14.0	5.3	48.0	10.5	171.0
	Sebastes schlegeli	1301.8	9254.0	2351.0	16550.0	4245.8	23771.0	3812.8	19576.0	18941.3	113603.0
	Other rock fishes	11.5	76.0	2.5	86.0	27.3	167.0	3.0	132.0	371.8	2171.0
	Muguil spp.	124.5	1415.0	835.0	3898.0	1036.8	4093.0	969.8	3596.0	3450.8	14685.0
	Pleurogrammus azonus	0.8	3.0	0.0	0.0	0.0	0.0	0.0	0.0	35.8	38.0
	Konosirus punctatus	0.0	0.0	0.0	0.0	0.0	0.0	127.0	181.0	127.0	181.0
	Stephanolepis sp.; *Thamnaconus* s	0.8	3.0	0.0	0.0	0.0	3.0	16.0	19.0	19.3	821.0
	Other finfish	6.0	14.0	32.0	33.0	6.3	24.0	3.0	55.0	53.3	212.0
	subtotal	**3320.5**	**29297.0**	**5925.0**	**48073.0**	**8766.3**	**72393.0**	**8049.3**	**64476.0**	**42932.5**	**369884.0**
Crusta-ceans	*Fenneropenaeus chinensis*	1208.5	2081.0	1150.0	1403.0	1084.0	2324.0	1179.0	2426.0	9297.9	13694.0
	Marsupenaeus japonicus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.6	39.0
	other crustacean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.0
	subtotal	**1208.5**	**2081.0**	**1150.0**	**1403.0**	**1084.0**	**2324.0**	**1179.0**	**2426.0**	**9324.5**	**13775.0**
Shellfish	*Crassostrea gigas*	10616.3	174117.0	13651.8	182229.0	26398.0	238326.0	23479.8	239270.0	148766.3	1941674.0
	Rapana venosa	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0		154.0
	Haliotis discus hannai	5.0	29.0	14.8	85.0	258.8	1065.0	306.5	1260.0	672.3	2991.0
	Chlamys farreri nipponensis	0.0	66.0	0.0	5.0	0.0	23.0	0.3	173.0	0.3	3799.0
	Cyclina sinensis	25.0	25.0	219.0	219.0	189.0	189.0	79.0	79.0	617.0	691.0
	Mactra chinensis	1.5	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2519.0
	Scapharca subcrenata	932.5	3842.0	93.5	413.0	552.8	2440.0	2695.3	10849.0	9937.3	43748.0
	Solen spp.	0.0	0.0	0.0	0.0	0.5	2.0	0.0	0.0	5175.8	36802.0
	Ruditapes philippinarum	14653.3	16433.0	9703.0	10652.0	25461.5	27494.0	25218.0	27570.0	136439.3	164967.0
	Meretrix lusoria	0.0	26.0	1.0	5.0	1.0	167.0	0.0	127.0	58.0	1645.0
	Atrina pectinata	309.0	1240.0	144.3	577.0	195.8	783.0	499.3	1997.0	1971.3	6861.0
	Scapharca broughtonii	0.0	7359.0	0.0	4745.0	0.0	4696.0	0.0	3134.0	174.0	104810.0
	Mactra veneriformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	654.0	680.0
	Mytilus spp.	1866.0	13653.0	1676.3	13201.0	901.3	15785.0	813.0	20409.0	35776.8	316571.0
	Other shellfish	0.0	279.0	0.0	302.0	0.0	93.0	0.0	21.0	10.0	1807.0
	subtotal	**28408.5**	**217078.0**	**25503.6**	**212433.0**	**53958.6**	**291063.0**	**53091.0**	**304889.0**	**340255.8**	**2629719.0**
Seaweeds	*Porphyra* spp.	58050.3	167909.0	70112.0	209995.0	67717.8	193553.0	80191.0	228554.0	634149.0	1827178.0
	Laminaria japonica	3676.5	17506.0	5220.3	24873.0	5988.5	25259.0	5293.3	22510.0	52023.0	234087.0
	Undaria pinnatifida	37104.5	175490.0	50881.5	242135.0	42537.3	198172.0	54686.5	261574.0	603514.5	2667752.0
	Gelidium amansii	0.0	0.0	1.0	4.0	0.0	0.0	0.0	0.0	5.0	20.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.0
	Codium fragile	0.0	7.0	18.0	72.0	0.0	53.0	9.5	142.0	27.5	491.0
	Hizikia fusiforme	1716.3	6865.0	2751.0	11016.0	8412.0	33661.0	5702.8	22814.0	57206.0	228885.0
	Enteromorpha spp.	1199.5	5760.0	2113.3	9291.0	116.3	1355.0	12.5	1154.0	9075.3	54429.0
	Other seaweeds	0.3	1.0	42.8	171.0	0.0	1.0	0.0	0.0	648.5	882.0
	subtotal	**101747.3**	**373538.0**	**131139.8**	**497557.0**	**124771.8**	**452054.0**	**145895.5**	**536748.0**	**1356649.3**	**5013726.0**
Others	*Halocynthia roretzi*	0.0	4603.0	0.0	9613.0	0.0	3116.0	0.0	6349.0	0.0	104076.0
	Stichopus japonicus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	1.0
	others	0.0	29230.0	0.0	12440.0	0.0	5295.0	0.0	2827.0	0.0	132375.0
	subtotal	**0.0**	**33833.0**	**0.0**	**22053.0**	**0.0**	**8411.0**	**0.0**	**9176.0**	**8.0**	**236452.0**
total		**134684.8**	**655827.0**	**163718.3**	**781519.0**	**188580.6**	**826245.0**	**208214.8**	**917715.0**	**1749170.1**	**8263556.0**

- Overview of marine farmed production for last 10 years

Table 32. Changes in total production of major farmed species from 1995 to 2004

(unit: M/T)

kind	species	1995		1996		1997		1998		1999		2000	
		YS	Total	YS	Total	YS	Total	YS	Total	YS	Total	YS	Total
Finfish	*Paralichthys olivaceus*	380.3	6733.0	827.0	8861.0	2674.3	26274.0	1828.8	22277.0	1525.5	21368.0	866.8	14127.0
	Sebastes schlegelii	111.8	985.0	381.0	1922.0	1764.5	11069.0	2337.0	12544.0	1600.3	9459.0	1035.5	8473.0
	other finfish	226.0	633.0	57.5	619.0	97.5	1778.0	171.3	0.0	446.8	2626.0	540.0	3386.0
	subtotal	**718.0**	**29297.0**	**1265.5**	**11402.0**	**4536.3**	**39121.0**	**4337.0**	**37323.0**	**3572.5**	**33453.0**	**2442.3**	**25986.0**
Crusta-ceans	*Fenneropenaeus chinensis*	352.8	404.0	338.8	377.0	1479.0	1533.0	737.3	846.0	915.5	1142.0	853.0	1158.0
	Penaeus japonicus	25.3	34.0	1.3	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	other crustacean	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	38.0	0.0	0.0
	subtotal	**378.1**	**438.0**	**340.1**	**382.0**	**1479.0**	**1537.0**	**737.3**	**846.0**	**915.5**	**1180.0**	**853.0**	**1158.0**
Shellfish	*Crassostrea gigas*	17252.3	191156.0	13709.3	185339.0	10525.3	200973.0	8800.8	175926.0	12197.0	177259.0	12136.0	177079.0
	Ruditapes philippinarum	7329.5	15260.0	8754.5	18478.0	8442.8	13958.0	12433.8	17178.0	11504.5	17.0	12938.5	17927.0
	other shellfish	12699.3	105836.0	12583.8	102921.0	10904.0	86942.0	2632.3	46650.0	2530.8	43755.0	1917.8	27602.0
	subtotal	**37281.1**	**312252.0**	**35047.6**	**306738.0**	**29872.0**	**301873.0**	**23866.8**	**239754.0**	**26232.3**	**221031.0**	**26994.5**	**222608.0**
Seaweeds	*Porphyra* spp.	67757.5	192960.0	55068.3	166199.0	47581.5	140236.0	70564.8	191578.0	71011.3	205706.0	46094.8	130488.0
	Undaria pinnatifida	93658.3	386819.0	73614.0	305813.0	105898.5	431872.0	53739.0	239742.0	45987.5	213706.0	45407.5	212429.0
	other seaweed	15970.8	69320.0	14458.8	66978.0	17261.8	75735.0	9431.8	38449.0	12235.5	54260.0	7353.8	31539.0
	subtotal	**177386.5**	**649099.0**	**143141.0**	**538990.0**	**170741.8**	**647843.0**	**133735.5**	**469769.0**	**129234.3**	**473672.0**	**98856.0**	**374456.0**
others	*Synthina roretzi*	0.0	22626.0	0.0	13093.0	0.0	22318.0	0.0	8177.0	0.0	11845.0	0.0	2336.0
	Stichopus japonicus	0.0	1.0	0.0	0.0	0.0	0.0	5.0	0.0	2.0	0.0	1.0	0.0
	others	0.0	3675.0	0.0	4205.0	0.0	2442.0	0.0	21361.0	0.0	24071.0	0.0	26829.0
	subtotal	**0.0**	**26302.0**	**0.0**	**17298.0**	**0.0**	**24760.0**	**5.0**	**29538.0**	**2.0**	**35916.0**	**1.0**	**29165.0**
total		**215763.7**	**1017388.0**	**179794.2**	**874810.0**	**206629.0**	**1015134.0**	**162681.6**	**777230.0**	**159956.6**	**765252.0**	**129146.8**	**653373.0**

Table 32. Continued

kind	species	2001		2002		2003		2004		total	total (country)
		YS	Total	YS	Total	YS	Total	YS	Total	(Yellow Sea)	
Finfish	*Paralichthys olivaceus*	1616.0	16426.0	2011.0	23348.0	2468.8	34533.0	2316.5	32141.0	16514.8	206088.0
	Sebastes schlegelii	1301.8	9254.0	2351.0	16550.0	4245.8	23771.0	3812.8	19576.0	18941.3	113603.0
	other finfish	402.8	3617.0	1563.0	8175.0	2051.8	14089.0	1920.0	12759.0	7476.5	47682.0
	subtotal	**3320.5**	**29297.0**	**5925.0**	**48073.0**	**8766.3**	**72393.0**	**8049.3**	**64476.0**	**42932.5**	**390821.0**
Crusta-ceans	*Fenneropenaeus chinensis*	1208.5	2081.0	1150.0	1403.0	1084.0	2324.0	1179.0	2426.0	9297.9	13694.0
	Penaeus japonicus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.6	39.0
	other crustacean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.0
	subtotal	**1208.5**	**2081.0**	**1150.0**	**1403.0**	**1084.0**	**2324.0**	**1179.0**	**2426.0**	**9324.5**	**13775.0**
Shellfish	*Crassostrea gigas*	10616.3	174117.0	13651.8	182229.0	26398.0	238326.0	23479.8	239270.0	148766.3	1941674.0
	Ruditapes philippinarum	14653.3	16433.0	9703.0	10652.0	25461.5	27494.0	25218.0	27570.0	136439.3	164967.0
	other shellfish	3139.0	26528.0	2148.8	19552.0	2099.1	25243.0	4393.3	38049.0	55046.6	523078.0
	subtotal	**28408.5**	**217078.0**	**25503.6**	**212433.0**	**53958.6**	**291063.0**	**53091.0**	**304889.0**	**340255.8**	**2629719.0**
Seaweeds	*Porphyra* spp.	58050.3	167909.0	70112.0	209995.0	67717.8	193553.0	80191.0	228554.0	634149.0	1827178.0
	Undaria pinnatifida	37104.5	175490.0	50881.5	242135.0	42537.3	198172.0	54686.5	261574.0	603514.5	2667752.0
	other seaweed	6592.5	30139.0	10146.3	45427.0	14516.8	60329.0	11018.0	46620.0	118985.8	518796.0
	subtotal	**101747.3**	**373538.0**	**131139.8**	**497557.0**	**124771.8**	**452054.0**	**145895.5**	**536748.0**	**1356649.3**	**5013726.0**
others	*Synthina roretzi*	0.0	4603.0	0.0	9613.0	0.0	3116.0	0.0	6349.0	0.0	104076.0
	Stichopus japonicus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	1.0
	others	0.0	29230.0	0.0	12440.0	0.0	5295.0	0.0	2827.0	0.0	132375.0
	subtotal	**0.0**	**33833.0**	**0.0**	**22053.0**	**0.0**	**8411.0**	**0.0**	**9176.0**	**8.0**	**236452.0**
total		**134684.8**	**655827.0**	**163718.3**	**781519.0**	**188580.6**	**826245.0**	**208214.8**	**917715.0**	**1749170.1**	**8284493.0**

Table 33. Overview of farmed production for last 10 years

		total production(M/T)				ratio	ratio %
year	kind	YS	TFW	TSW	TFW+TSW	%(YS/TSW)	(YS/(TFW+TSW
1995	finfish	718.0	28,057.0	8,360.0	36,417.0	8.59	1.97
	crustacean	378.1	218.0	438.0	656.0	86.32	57.64
	shellfish	37,281.0	933.0	312,252.0	313,185.0	11.94	11.90
	seaweed	177,386.5	5.0	649,099.0	649,104.0	27.33	27.33
	others	0.0	15.0	26,302.0	26,317.0	0.00	0.00
	total	**215,763.6**	**29,228.0**	**996,451.0**	**1,025,679.0**	**21.65**	**21.04**
1996	finfish	1,265.5	29,049.0	11,402.0	40,451.0	11.10	3.13
	crustacean	340.1	120.0	382.0	502.0	89.03	67.75
	shellfish	35,047.6	1,019.0	306,738.0	307,757.0	11.43	11.39
	seaweed	143,141.0	11.0	538,990.0	539,001.0	26.56	26.56
	others	0.0	49.0	17,298.0	17,347.0	0.00	0.00
	total	**179,794.2**	**30,248.0**	**874,810.0**	**905,058.0**	**20.55**	**19.87**
1997	finfish	4,536.3	30,746.0	39,121.0	69,867.0	11.60	6.49
	crustacean	1,479.0	140.0	1,537.0	1,677.0	96.23	88.19
	shellfish	29,872.0	806.0	301,873.0	302,679.0	9.90	9.87
	seaweed	170,741.8	1.0	647,843.0	647,844.0	26.36	26.36
	others	0.0	103.0	24,760.0	24,863.0	0.00	0.00
	total	**206,629.0**	**31,796.0**	**1,015,134.0**	**1,046,930.0**	**20.35**	**19.74**
1998	finfish	4,337.0	25,624.0	37,323.0	62,947.0	11.62	6.89
	crustacean	737.3	121.0	846.0	967.0	87.15	76.25
	shellfish	23,866.8	1,040.0	239,754.0	240,794.0	9.95	9.91
	seaweed	133,735.5	5.0	469,769.0	469,774.0	28.47	28.47
	others	5.0	62.0	29,538.0	29,600.0	0.02	0.02
	total	**162,681.6**	**26,852.0**	**777,230.0**	**804,082.0**	**20.93**	**20.23**
1999	finfish	3,572.5	16,300.0	33,453.0	49,753.0	10.68	7.18
	crustacean	915.5	136.0	1,180.0	1,316.0	77.58	69.57
	shellfish	26,232.3	1,302.0	221,031.0	222,333.0	11.87	11.80
	seaweed	129,234.3	4.0	473,672.0	473,676.0	27.28	27.28
	others	2.0	104.0	35,916.0	36,020.0	0.01	0.01
	total	**159,956.6**	**17,846.0**	**765,252.0**	**783,098.0**	**20.90**	**20.43**
2000	finfish	2,442.3	19,614.0	25,986.0	45,600.0	9.40	5.36
	crustacean	853.0	114.0	1,158.0	1,272.0	73.66	67.06
	shellfish	26,994.5	675.0	222,608.0	223,283.0	12.13	12.09
	seaweed	98,856.0	8.0	374,456.0	374,464.0	26.40	26.40
	others	1.0	174.0	29,165.0	29,339.0	0.00	0.00
	total	**129,146.8**	**20,585.0**	**653,373.0**	**673,958.0**	**19.77**	**19.16**
2001	finfish	3,320.5	16,932.0	29,297.0	46,229.0	11.33	7.18
	crustacean	1,208.5	78.0	2,081.0	2,159.0	58.07	55.97
	shellfish	28,408.5	1,027.0	217,078.0	218,105.0	13.09	13.03
	seaweed	101,747.3	0.0	373,538.0	373,538.0	27.24	27.24
	others	0.0	104.0	33,833.0	33,937.0	0.00	0.00
	total	**134,684.8**	**18,141.0**	**655,827.0**	**673,968.0**	**20.54**	**19.98**
2002	finfish	5,925.0	16,280.0	48,073.0	64,353.0	12.33	9.21
	crustacean	1,150.0	77.0	1,403.0	1,480.0	81.97	77.70
	shellfish	25,503.6	2,049.0	212,433.0	214,482.0	12.01	11.89
	seaweed	131,139.5	0.0	497,557.0	497,557.0	26.36	26.36
	others	0.0	105.0	22,053.0	22,158.0	0.00	0.00
	total	**163,718.3**	**18,511.0**	**781,519.0**	**800,030.0**	**20.95**	**20.46**
2003	finfish	8,766.3	17,399.0	72,393.0	89,792.0	12.11	9.76
	crustacean	1,084.0	127.0	2,324.0	2,451.0	46.64	44.23
	shellfish	53,958.6	2,016.0	291,063.0	293,079.0	18.54	18.41
	seaweed	124,771.8	0.0	452,054.0	452,054.0	27.60	27.60
	others	0.0	138.0	8,411.0	8,549.0	0.00	0.00
	total	**188,580.6**	**19,680.0**	**826,245.0**	**845,925.0**	**22.82**	**22.29**
2004	finfish	8,049.3	20,415.0	64,476.0	84,891.0	12.48	9.48
	crustacean	1,179.0	78.0	2,426.0	2,504.0	48.60	47.08
	shellfish	53,091.0	4,670.0	304,889.0	309,559.0	17.41	17.15
	seaweed	145,895.5	0.0	536,748.0	536,748.0	27.18	27.18
	others	0.0	136.0	9,176.0	9,312.0	0.00	0.00
	total	**208,214.8**	**25,299.0**	**917,715.0**	**943,014.0**	**22.69**	**22.08**
grand total		1,749,170.1	238,186.0	8,263,556.0	8,501,742.0	211.16	205.28

Remark: TSW: Total national production of mariculture
TFW: Total national production of fresh water
YS: Regional production of mariculture of Yellow Sea

Table 34. Overview of marine farmed production for last 10 years

	Year										
Kind	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**total**
Finfish	718	1265.5	4536.3	4337	3572.5	2442.3	3320.5	5925	8766.3	8049.3	42932.7
Crustacean	378.1	340.1	1479	737.3	915.5	853	1208.5	1150	1084	1179	9324.5
Shellfish	37281.1	35047.6	29872	23866.8	26232.3	26994.5	28408.5	25503.6	53958.6	53091	340256
Seaweed	177387	143141	170742	133736	129234	98856	101747	131140	124772	145896	1356650
Others	0	0	0	5	2	1	0	0	0	0	8
Total	215764	179794	206629	162682	159957	129147	134685	163718	188581	208215	1749171

Table 35. Production ratio of marine farmed organisms (kinds) for last 10 years

	Year										
Kind	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**total**
Finfish(%)	0.3	0.7	2.2	2.7	2.2	1.9	2.5	3.6	4.6	3.9	2.5
Crustacean(%)	0.2	0.2	0.7	0.5	0.6	0.7	0.9	0.7	0.6	0.6	0.5
Shellfish(%)	17.3	19.5	14.5	14.7	16.4	20.9	21.1	15.6	28.6	25.5	19.5
Seaweed(%)	82.2	79.6	82.6	82.2	80.8	76.5	75.5	80.1	66.2	70.1	77.6
Total(%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total(mt)	215764	179794	206629	162682	159957	129147	134685	163718	188581	208215	1749171

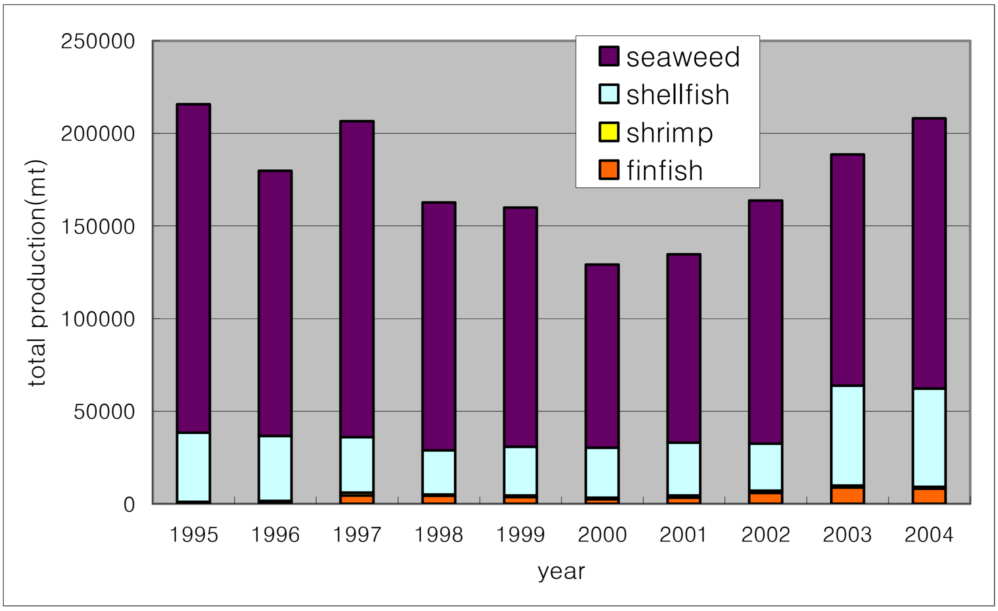


Figure 27. Overview of marine farmed production in the west coast of Korea for last 10 years (unit: M/T).

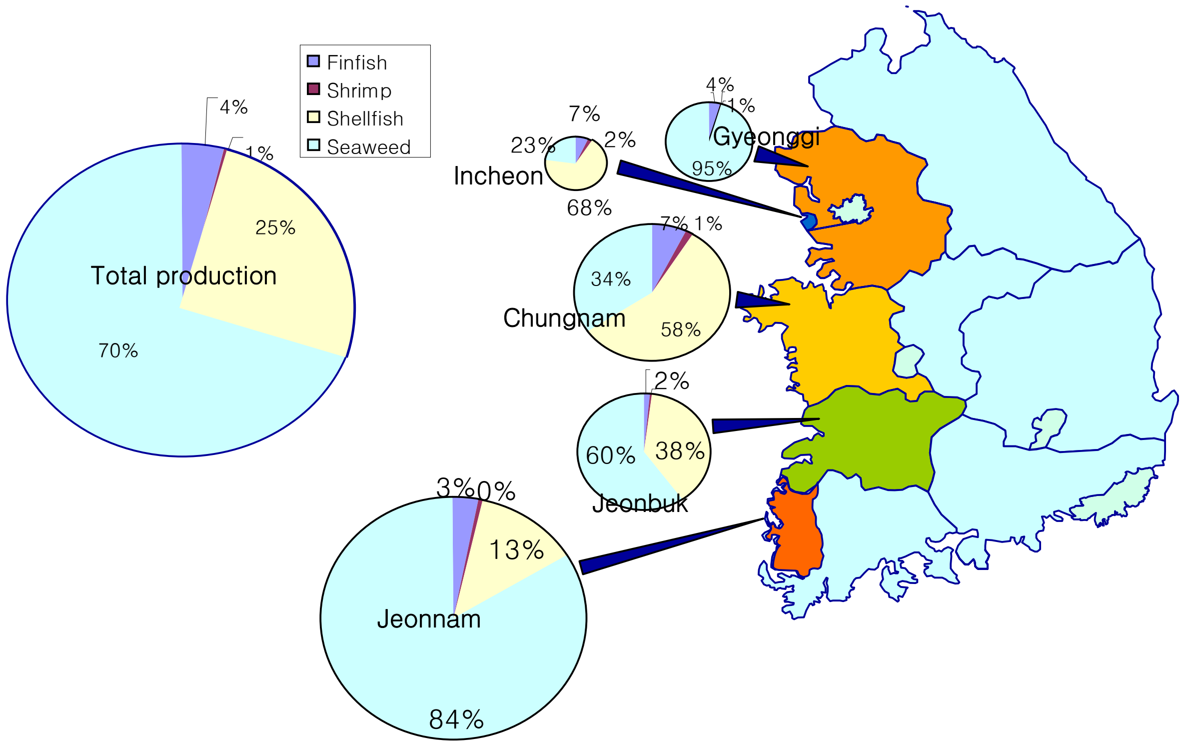


Figure 28. Production ratio of marine farmed organisms from the west coast of Korea in 2004.

- Annual variation of aquaculture area in marine farms from 1995 to 2004

Table 36. Aquaculture area of marine farmed species in the west coast of Korea in 1995

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	108.0	4.0	291.0	278.0	322.0	1003.0
Crustacean	*Fenneropenaeus chinensis*	95.0	18.0	951.0	64.0	21.0	1149.0
	subtotal	95.0	18.0	951.0	64.0	21.0	1149.0
Shellfish	*Crassostrea gigas*	42.0	72.0	684.0	124.0	530.0	1452.0
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	123.0	0.0	363.0	124.0	24.0	634.0
	Chlamys farreri nipponensis	10.0	0.0	0.0	0.0	2.0	12.0
	Cyclina sinensis	160.0	23.0	86.0	560.0	40.0	869.0
	Mactra chinensis	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca subcrenata	0.0	10.0	235.0	217.0	185.0	647.0
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	36.0	195.0	971.0	3365.0	315.0	4882.0
	Meretrix lusoria	0.0	0.0	87.0	0.0	144.0	231.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	64.0	0.0	140.0	35.0	0.0	239.0
	Mactra veneriformis	0.0	0.0	0.0	233.0	0.0	233.0
	Mytilus spp.	0.0	0.0	145.0	130.0	0.0	275.0
	Other shellfish	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	435.0	300.0	2711.0	4788.0	1240.0	9474.0
Seaweed	*Porphyra* spp.	814.0	719.0	4388.0	5097.0	8677.0	19695.0
	Laminaria japonica	20.0	0.0	0.0	30.0	7.0	57.0
	Undaria pinnatifida	2.0	0.0	22.0	40.0	168.0	232.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	0.0	0.0	105.0	105.0
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	32.0	32.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	836.0	719.0	4410.0	5167.0	8989.0	20121.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	21.0	95.0	0.0	116.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	40.0	0.0	28.0	68.0
	Others	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	0.0	0.0	61.0	95.0	28.0	184.0
Collective farms	shellfish	ND	ND	ND	ND	ND	ND
	subtotal	ND	ND	ND	ND	ND	ND
Total		**1474.0**	**1041.0**	**8424.0**	**10392.0**	**10600.0**	**31931.0**

Statisics includes licensed area only. Area of permission and notification is not included.
Area of collective farms is not included.

Table 37. Aquaculture area of marine farmed species in the west coast of Korea in 1996

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	111.0	4.0	270.0	359.0	361.0	1105.0
Crustacean	*Fenneropenaeus chinensis*	211.0	27.0	955.0	135.0	30.0	1358.0
	subtotal	211.0	27.0	955.0	135.0	30.0	1358.0
Shellfish	*Crassostrea gigas*	47.0	66.0	662.0	114.0	783.0	1672.0
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	118.0	0.0	309.0	137.0	16.0	580.0
	Chlamys farreri nipponensis	20.0	417.0	20.0	28.0	8.0	493.0
	Cyclina sinensis	170.0	23.0	478.0	99.0	144.0	914.0
	Mactra chinensis	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca subcrenata	0.0	10.0	261.0	178.0	208.0	657.0
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	36.0	195.0	945.0	2208.0	144.0	3528.0
	Meretrix lusoria	0.0	0.0	51.0	0.0	0.0	51.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	84.0	0.0	120.0	70.0	20.0	294.0
	Mactra veneriformis	0.0	0.0	0.0	185.0	0.0	185.0
	Mytilus spp.	0.0	0.0	60.0	140.0	0.0	200.0
	Other shellfish	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	475.0	711.0	2906.0	3159.0	1323.0	8574.0
Seaweed	*Porphyra* spp.	708.0	719.0	3445.0	4360.0	8823.0	18055.0
	Laminaria japonica	20.0	0.0	0.0	30.0	7.0	57.0
	Undaria pinnatifida	26.0	0.0	42.0	10.0	135.0	213.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	0.0	0.0	152.0	152.0
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	64.0	64.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	754.0	719.0	3487.0	4400.0	9181.0	18541.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	21.0	95.0	0.0	116.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	40.0	0.0	28.0	68.0
	Others	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	0.0	0.0	61.0	95.0	28.0	184.0
Collective farms	shellfish	ND	ND	ND	ND	ND	ND
	subtotal	ND	ND	ND	ND	ND	ND
Total		**1551.0**	**1461.0**	**7679.0**	**8148.0**	**10923.0**	**29762.0**

Statisics includes licensed area only. Area of permission and notification is not included.
Area of collective farms is not included.

Table 38. Aquaculture area of marine farmed species in the west coast of Korea in 1997

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	75.0	36.0	283.0	361.0	387.8	1142.8
Crustacean	*Fenneropenaeus chinensis*	223.0	0.0	780.0	77.0	19.0	1099.0
	subtotal	223.0	0.0	780.0	77.0	19.0	1099.0
Shellfish	*Crassostrea gigas*	95.0	56.0	704.0	109.0	796.0	1760.0
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	132.0	0.0	328.0	154.0	11.0	625.0
	Chlamys farreri nipponensis	20.0	0.0	0.0	40.0	20.0	80.0
	Cyclina sinensis	260.0	23.0	80.0	453.0	65.0	881.0
	Mactra chinensis	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca subcrenata	0.0	10.0	256.0	148.0	169.5	583.5
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	36.0	165.0	1092.0	1552.0	442.5	3287.5
	Meretrix lusoria	0.0	0.0	51.0	40.0	114.0	205.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	114.0	0.0	120.0	440.0	28.0	702.0
	Mactra veneriformis	0.0	0.0	0.0	0.0	0.0	0.0
	Mytilus spp.	0.0	0.0	60.0	150.0	0.0	210.0
	Other shellfish	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	657.0	254.0	2691.0	3086.0	1646.0	8334.0
Seaweed	*Porphyra* spp.	788.0	779.0	3844.0	2825.0	9369.0	17605.0
	Laminaria japonica	20.0	0.0	0.0	30.0	8.0	58.0
	Undaria pinnatifida	27.0	0.0	42.0	10.0	136.0	215.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	0.0	0.0	167.0	167.0
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	54.0	54.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	835.0	779.0	3886.0	2865.0	9734.0	18099.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	9.0	0.0	0.0	9.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	40.0	0.0	27.5	67.5
	Others	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	0.0	0.0	49.0	0.0	27.5	76.5
Collective farms	shellfish	ND	ND	ND	ND	ND	ND
	subtotal	ND	ND	ND	ND	ND	ND
Total		**1790.0**	**1069.0**	**7689.0**	**6389.0**	**11814.3**	**28751.3**

Statisics includes licensed area only. Area of permission and notification is not included.
Area of collective farms is not included.

Table 39. Aquaculture area of marine farmed species in the west coast of Korea in 1998

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	41.0	33.0	285.0	402.0	433.8	1194.8
Crustacean	*Fenneropenaeus chinensis*	231.0	0.0	783.0	123.0	19.0	1156.0
	subtotal	231.0	0.0	783.0	123.0	19.0	1156.0
Shellfish	*Crassostrea gigas*	123.0	80.0	749.0	109.0	795.3	1856.3
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	
	Haliotis discus hannai	132.0	34.0	341.0	238.0	47.0	792.0
	Chlamys farreri nipponensis	20.0	0.0	0.0	40.0	50.0	110.0
	Cyclina sinensis	310.0	23.0	85.0	448.0	85.0	951.0
	Mactra chinensis	0.0	46.0	0.0	0.0	0.0	46.0
	Scapharca subcrenata	0.0	10.0	226.0	212.0	169.5	617.5
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	61.0	0.0	1149.0	1406.0	544.0	3160.0
	Meretrix lusoria	0.0	0.0	51.0	40.0	0.0	91.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	114.0	145.0	140.0	440.0	28.0	867.0
	Mactra veneriformis	0.0	0.0	0.0	0.0	143.5	143.5
	Mytilus spp.	0.0	0.0	60.0	150.0	0.0	210.0
	Other shellfish	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	760.0	338.0	2801.0	3083.0	1862.3	8844.3
Seaweed	*Porphyra* spp.	770.0	338.0	3791.0	2814.0	9490.0	17203.0
	Laminaria japonica	20.0	0.0	0.0	30.0	8.0	58.0
	Undaria pinnatifida	27.0	0.0	47.0	10.0	131.0	215.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	0.0	0.0	167.0	167.0
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	54.0	54.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	817.0	338.0	3838.0	2854.0	9850.0	17697.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	9.0	0.0	0.0	9.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	40.0	0.0	27.5	67.5
	Others	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	0.0	0.0	49.0	0.0	27.5	76.5
Collective farms	shellfish	ND	ND	ND	ND	ND	ND
	subtotal	ND	ND	ND	ND	ND	ND
Total		**1849.0**	**709.0**	**7756.0**	**6462.0**	**12192.6**	**28968.6**

Statisics includes all types of farms(licensed, permitted and notified farms).
Area of collective farms is not included.

Table 40. Aquaculture area of marine farmed species in the west coast of Korea in 1999

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	77.0	30.0	251.0	405.0	489.1	1252.1
Crustacean	*Fenneropenaeus chinensis*	221.0	0.0	647.0	73.0	19.0	960.0
	subtotal	221.0	0.0	647.0	73.0	19.0	960.0
Shellfish	*Crassostrea gigas*	120.0	71.0	735.0	118.0	820.1	1864.1
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	
	Haliotis discus hannai	140.0	0.0	346.0	227.0	39.0	752.0
	Chlamys farreri nipponensis	20.0	4.0	0.0	40.0	42.0	106.0
	Cyclina sinensis	310.0	0.0	91.0	471.0	85.0	957.0
	Mactra chinensis	0.0	46.0	0.0	0.0	0.0	46.0
	Scapharca subcrenata	0.0	10.0	226.0	327.0	166.5	729.5
	Solen spp.	0.0	0.0	0.0	0.0	0.0	90.0
	Ruditapes philippinarum	64.0	145.0	1209.0	1392.0	636.0	3446.0
	Meretrix lusoria	0.0	0.0	51.0	40.0	0.0	91.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	119.0	0.0	130.0	510.0	35.0	794.0
	Mactra veneriformis	0.0	0.0	0.0	0.0	154.0	154.0
	Mytilus spp.	0.0	0.0	50.0	70.0	0.0	120.0
	Other shellfish	0.0	30.0	0.0	60.0	0.0	90.0
	subtotal	773.0	306.0	2838.0	3255.0	1977.6	9149.6
Seaweed	*Porphyra* spp.	746.0	338.0	3733.0	2544.0	9445.0	16806.0
	Laminaria japonica	20.0	0.0	0.0	30.0	30.0	80.0
	Undaria pinnatifida	27.0	0.0	117.0	0.0	131.0	275.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	0.0	0.0	190.0	190.0
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	39.0	39.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	793.0	338.0	3850.0	2574.0	9835.0	17390.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	13.0	0.0	0.0	13.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	30.0	0.0	15.0	45.0
	Others	0.0	0.0	1.0	0.0	0.0	1.0
	subtotal	0.0	0.0	44.0	0.0	15.0	59.0
Collective farms	shellfish	ND	ND	ND	ND	ND	ND
	subtotal	ND	ND	ND	ND	ND	ND
Total		**1864.0**	**674.0**	**7630.0**	**6307.0**	**12335.7**	**28810.7**

Statisics includes all types of farms(licensed, permitted and notified farms).
Area of collective farms is not included.

Table 41. Aquaculture area of marine farmed species in the west coast of Korea in 2000

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	174.0	28.0	267.0	169.0	518.3	1156.3
Crustacean	*Fenneropenaeus chinensis*	98.0	6.0	636.0	281.0	19.0	1040.0
	subtotal	98.0	6.0	636.0	281.0	19.0	1040.0
Shellfish	*Crassostrea gigas*	278.0	101.0	800.0	80.0	820.8	2079.8
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	160.0	61.0	350.0	294.0	39.0	904.0
	Chlamys farreri nipponensis	85.0	0.0	0.0	40.0	42.0	167.0
	Cyclina sinensis	355.0	0.0	91.0	476.0	85.0	1007.0
	Mactra chinensis	0.0	56.0	0.0	0.0	0.0	56.0
	Scapharca subcrenata	0.0	10.0	226.0	380.0	173.5	789.5
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	76.0	145.0	1236.0	1381.0	717.0	3555.0
	Meretrix lusoria	39.0	0.0	51.0	80.0	0.0	170.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	139.0	0.0	140.0	510.0	43.0	832.0
	Mactra veneriformis	0.0	0.0	0.0	60.0	154.0	214.0
	Mytilus spp.	0.0	0.0	35.0	20.0	0.0	55.0
	Other shellfish	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	1132.0	373.0	2929.0	3321.0	2074.3	9829.3
Seaweed	*Porphyra* spp.	583.0	430.0	3714.0	2523.0	9393.0	16643.0
	Laminaria japonica	20.0	0.0	0.0	0.0	52.0	72.0
	Undaria pinnatifida	47.0	0.0	117.0	0.0	131.0	295.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	0.0	0.0	212.5	212.5
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	39.0	39.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	650.0	430.0	3831.0	2523.0	9827.5	17261.5
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	13.0	0.0	0.0	13.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	30.0	0.0	0.0	30.0
	Others	0.0	0.0	1.0	0.0	0.0	1.0
	subtotal	0.0	0.0	44.0	0.0	0.0	44.0
Collective farms	shellfish	ND	ND	ND	ND	13037.4	13037.4
	subtotal	ND	ND	ND	ND	13037.4	13037.4
Total		**2054.0**	**837.0**	**7707.0**	**6294.0**	**12439.1**	**29331.1**

Statisics includes all types of farms(licensed, permitted and notified farms).
Area of collective farms is not included.

Table 42. Aquaculture area of marine farmed species in the west coast of Korea in 2001

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	187.2	28.0	290.3	176.8	577.2	1259.5
Crustacean	*Fenneropenaeus chinensis*	201.2	121.6	667.4	384.5	45.9	1420.6
	subtotal	201.2	121.6	667.4	384.5	45.9	1420.6
Shellfish	*Crassostrea gigas*	567.0	29.0	782.0	104.0	788.8	2270.8
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	171.2	64.0	353.3	236.0	46.0	870.5
	Chlamys farreri nipponensis	89.0	2.0	0.0	30.0	45.0	166.0
	Cyclina sinensis	390.0	0.0	104.0	480.0	85.0	1059.0
	Mactra chinensis	0.0	20.0	0.0	0.0	0.0	20.0
	Scapharca subcrenata	0.0	10.0	197.0	391.0	156.5	754.5
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	117.0	20.0	1449.0	1377.0	702.0	3665.0
	Meretrix lusoria	30.0	0.0	51.0	40.0	0.0	121.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	169.0	0.0	170.0	550.0	53.0	942.0
	Mactra veneriformis	20.0	0.0	0.0	60.0	154.0	234.0
	Mytilus spp.	0.0	0.0	37.0	50.0	0.0	87.0
	Other shellfish	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	1553.2	145.0	3143.3	3318.0	2030.3	10189.8
Seaweed	*Porphyra* spp.	534.0	370.0	3411.0	2625.0	9388.0	16328.0
	Laminaria japonica	22.0	0.0	0.0	0.0	52.0	74.0
	Undaria pinnatifida	47.0	0.0	139.0	0.0	131.0	317.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	0.0	10.0	212.5	222.5
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	44.0	44.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	603.0	370.0	3550.0	2635.0	9827.5	16985.5
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	31.0	0.0	0.0	31.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	25.0	0.0	5.0	30.0
	Others	0.0	125.0	1.0	0.0	0.0	126.0
	subtotal	0.0	125.0	57.0	0.0	5.0	187.0
Collective farms	shellfish	1274.0	519.0	3993.0	1190.0	13624.0	20600.0
	subtotal	1274.0	519.0	3993.0	1190.0	13624.0	20600.0
Total		**3818.6**	**1308.6**	**11701.0**	**7704.3**	**26109.9**	**50642.4**

Statisics includes all types of farms(licensed, permitted and notified farms).

Table 43. Aquaculture area of marine farmed species in the west coast of Korea in 2002

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	339.5	29.2	286.4	112.1	608.7	1375.9
Crustacean	*Fenneropenaeus chinensis*	63.7	242.2	744.0	407.6	214.5	1672.0
	subtotal	63.7	242.2	744.0	407.6	214.5	1672.0
Shellfish	*Crassostrea gigas*	572.0	186.0	800.0	89.0	834.0	2481.0
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	207.9	0.0	367.3	239.0	90.1	904.3
	Chlamys farreri nipponensis	85.0	2.0	0.0	10.0	39.0	136.0
	Cyclina sinensis	410.0	0.0	110.0	480.0	85.0	1085.0
	Mactra chinensis	0.0	56.0	0.0	0.0	0.0	56.0
	Scapharca subcrenata	0.0	61.0	197.0	386.0	108.0	752.0
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	117.0	177.0	1555.0	1433.0	702.0	3984.0
	Meretrix lusoria	30.0	0.0	51.0	40.0	0.0	121.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	169.0	0.0	170.0	605.0	45.0	989.0
	Mactra veneriformis	20.0	0.0	0.0	60.0	154.0	234.0
	Mytilus spp.	0.0	0.0	37.0	30.0	0.0	67.0
	Other shellfish	0.0	21.0	0.0	0.0	0.0	21.0
	subtotal	1610.9	503.0	3287.3	3372.0	2057.1	10830.3
Seaweed	*Porphyra* spp.	528.0	904.0	3176.0	2410.0	9383.0	16401.0
	Laminaria japonica	50.0	0.0	22.0	0.0	62.0	134.0
	Undaria pinnatifida	47.0	0.0	144.0	0.0	128.0	319.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	10.0	10.0	193.0	213.0
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	45.0	45.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	625.0	904.0	3352.0	2420.0	9811.0	17112.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	31.0	0.0	0.0	31.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	25.0	0.0	5.0	30.0
	Others	0.0	43.0	1.0	0.0	0.0	44.0
	subtotal	0.0	43.0	57.0	0.0	5.0	105.0
Collective farms	shellfish	1131.0	853.0	4329.0	1204.0	13624.0	21141.0
	subtotal	1131.0	853.0	4329.0	1204.0	13624.0	21141.0
Total		**3770.1**	**2574.4**	**12055.7**	**7515.7**	**26320.3**	**52236.2**

Statisics includes all types of farms(licensed, permitted and notified farms).

Table 44. Aquaculture area of marine farmed species in the west coast of Korea in 2003

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	165.6	22.1	297.4	492.3	598.5	1575.9
Crustacean	*Fenneropenaeus chinensis*	217.0	184.0	435.0	418.0	194.3	1448.3
	subtotal	217.0	184.0	435.0	418.0	194.3	1448.3
Shellfish	*Crassostrea gigas*	184.0	185.0	697.0	89.0	834.0	1989.0
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	173.1	64.0	376.5	243.3	134.5	991.4
	Chlamys farreri nipponensis	85.0	2.0	10.0	10.0	47.0	154.0
	Cyclina sinensis	285.0	61.0	120.0	436.0	85.0	987.0
	Mactra chinensis	0.0	56.0	0.0	0.0	0.0	56.0
	Scapharca subcrenata	0.0	0.0	185.0	386.0	108.0	679.0
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	393.0	247.0	1737.0	1432.0	676.0	4485.0
	Meretrix lusoria	90.0	0.0	51.0	40.0	0.0	181.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	253.0	0.0	158.0	615.0	45.0	1071.0
	Mactra veneriformis	0.0	0.0	34.0	60.0	154.0	248.0
	Mytilus spp.	0.0	0.0	37.0	30.0	0.0	67.0
	Other shellfish	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	1463.1	615.0	3405.5	3341.3	2083.5	10908.4
Seaweed	*Porphyra* spp.	579.0	834.0	3041.0	2436.0	9221.0	16111.0
	Laminaria japonica	56.0	0.0	22.0	0.0	59.0	137.0
	Undaria pinnatifida	69.0	0.0	180.0	0.0	128.0	377.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	10.0	10.0	193.0	213.0
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	45.0	45.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	704.0	834.0	3253.0	2446.0	9646.0	16883.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	19.0	19.0
	Stichopus japonicus	0.0	0.0	23.0	0.0	0.0	23.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	0.0	0.0	5.0	5.0
	Others	0.0	0.0	12.0	1.0	0.0	13.0
	subtotal	0.0	0.0	35.0	1.0	24.0	60.0
Collective farms	shellfish	1591.0	2788.0	4650.0	1204.0	13738.0	23971.0
	subtotal	1591.0	2788.0	4650.0	1204.0	13738.0	23971.0
Total		**4140.7**	**4443.1**	**12075.9**	**7902.6**	**26284.3**	**54846.6**

Statisics includes all types of farms(licensed, permitted and notified farms).

Table 45. Aquaculture area of marine farmed species in the west coast of Korea in 2004

(unit: ha)

Kind	species	Province					
		Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish	subtotal	219.8	33.7	302.9	85.3	555.1	1196.8
Crustacean	*Fenneropenaeus chinensis*	99.3	139.6	752.6	398.4	252.5	1642.4
	subtotal	99.3	139.6	752.6	398.4	252.5	1642.4
Shellfish	*Crassostrea gigas*	488.0	188.0	728.0	89.0	834.5	2327.5
	Rapana venosa	0.0	0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	192.2	61.0	394.3	195.0	312.1	1154.6
	Chlamys farreri nipponensis	95.0	30.0	11.0	10.0	57.0	203.0
	Cyclina sinensis	280.0	61.0	140.0	455.0	85.0	1021.0
	Mactra chinensis	0.0	46.0	0.0	0.0	0.0	46.0
	Scapharca subcrenata	0.0	0.0	145.0	386.0	118.0	649.0
	Solen spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	112.0	247.0	1445.0	1306.0	676.0	3786.0
	Meretrix lusoria	90.0	0.0	51.0	40.0	0.0	181.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	258.0	0.0	168.0	615.0	0.0	1041.0
	Mactra veneriformis	0.0	0.0	18.0	60.0	154.0	232.0
	Mytilus spp.	0.0	0.0	40.0	20.0	0.0	60.0
	Other shellfish	0.0	0.0	0.0	0.0	3.0	3.0
	subtotal	1515.2	633.0	3140.3	3176.0	2239.6	10704.1
Seaweed	*Porphyra* spp.	427.0	799.0	3155.0	2552.0	9108.0	16041.0
	Laminaria japonica	83.0	0.0	27.0	0.0	155.5	265.5
	Undaria pinnatifida	49.0	0.0	180.0	0.0	118.0	347.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	0.0	0.0	10.0	10.0	192.5	212.5
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	0.0	0.0	0.0	0.0	47.0	47.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	559.0	799.0	3372.0	2562.0	9621.0	16913.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0
	Stichopus japonicus	0.0	0.0	25.0	50.0	0.0	75.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	0.0	0.0	0.0	0.0	0.0	0.0
	Others	16.2	0.0	6.0	12.5	7.5	42.2
	subtotal	16.2	0.0	31.0	62.5	7.5	117.2
Collective farms	shellfish	1638.0	3621.0	4576.0	1361.0	13945.0	25141.0
	subtotal	1638.0	3621.0	4576.0	1361.0	13945.0	25141.0
Total		**4047.5**	**5226.3**	**12174.8**	**7645.2**	**26620.7**	**55714.5**

Statisics includes all types of farms(licensed, permitted and notified farms).

- Changes in aquaculture area of marine farmed species for last 10 years

Table 46, Aquaculture area of marine farmed species in the west coast of Korea for last 10 years (unit: ha)

Kind	species	years									
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Finfish	subtotal	1003.0	1105.0	1142.8	1194.8	1252.1	1156.3	1259.5	1375.9	1575.9	1196.8
Crustacean	*Fenneropenaeus chinensis*	1149.0	1358.0	1099.0	1156.0	960.0	1040.0	1420.6	1672.0	1448.3	1642.4
	subtotal	1149.0	1358.0	1099.0	1156.0	960.0	1040.0	1420.6	1672.0	1448.3	1642.4
Shellfish	*Crassostrea gigas*	1452.0	1672.0	1760.0	1856.3	1864.1	2079.8	2270.8	2481.0	1989.0	2327.5
	Rapana venosa	0.0	0.0	0.0			0.0	0.0	0.0	0.0	0.0
	Haliotis discus hannai	634.0	580.0	625.0	792.0	752.0	904.0	870.5	904.3	991.4	1154.6
	Chlamys farreri nipponensis	12.0	493.0	80.0	110.0	106.0	167.0	166.0	136.0	154.0	203.0
	Cyclina sinensis	869.0	914.0	881.0	951.0	957.0	1007.0	1059.0	1085.0	987.0	1021.0
	Mactra chinensis	0.0	0.0	0.0	46.0	46.0	56.0	20.0	56.0	56.0	46.0
	Scapharca subcrenata	647.0	657.0	583.5	617.5	729.5	789.5	754.5	752.0	679.0	649.0
	Solen spp.	0.0	0.0	0.0	0.0	90.0	0.0	0.0	0.0	0.0	0.0
	Ruditapes philippinarum	4882.0	3528.0	3287.5	3160.0	3446.0	3555.0	3665.0	3984.0	4485.0	3786.0
	Meretrix lusoria	231.0	51.0	205.0	91.0	91.0	170.0	121.0	121.0	181.0	181.0
	Atrina pectinata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Scapharca broughtonii	239.0	294.0	702.0	867.0	794.0	832.0	942.0	989.0	1071.0	1041.0
	Mactra veneriformis	233.0	185.0	0.0	143.5	154.0	214.0	234.0	234.0	248.0	232.0
	Mytilus spp.	275.0	200.0	210.0	210.0	120.0	55.0	87.0	67.0	67.0	60.0
	Other shellfish	0.0	0.0	0.0	0.0	90.0	0.0	0.0	21.0	0.0	3.0
	subtotal	9474.0	8574.0	8334.0	8844.3	9149.6	9829.3	10189.8	10830.3	10908.4	10704.1
Seaweed	*Porphyra* spp.	19695.0	18055.0	17605.0	17203.0	16806.0	16643.0	16328.0	16401.0	16111.0	16041.0
	Laminaria japonica	57.0	57.0	58.0	58.0	80.0	72.0	74.0	134.0	137.0	265.5
	Undaria pinnatifida	232.0	213.0	215.0	215.0	275.0	295.0	317.0	319.0	377.0	347.0
	Gelidium amansii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gigartina spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Codium fragile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Hizikia fusiforme	105.0	152.0	167.0	167.0	190.0	212.5	222.5	213.0	213.0	212.5
	Enteromorpha spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sargassum fulvellum	32.0	64.0	54.0	54.0	39.0	39.0	44.0	45.0	45.0	47.0
	Other seaweeds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	subtotal	20121.0	18541.0	18099.0	17697.0	17390.0	17261.5	16985.5	17112.0	16883.0	16913.0
Others	*Halocynthia roretzi*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.0	0.0
	Stichopus japonicus	116.0	116.0	9.0	9.0	13.0	13.0	31.0	31.0	23.0	75.0
	Styela clava	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	polychaetes	68.0	68.0	67.5	67.5	45.0	30.0	30.0	30.0	5.0	0.0
	Others	0.0	0.0	0.0	0.0	1.0	1.0	126.0	44.0	13.0	42.2
	subtotal	184.0	184.0	76.5	76.5	59.0	44.0	187.0	105.0	60.0	117.2
Collective farms	shellfish	ND	ND	ND	ND	ND	ND	20600.0	21141.0	23971.0	25141.0
	subtotal	ND	ND	ND	ND	ND	ND	20600.0	21141.0	23971.0	25141.0
	Total	31931.0	29762.0	28751.3	28968.6	28810.7	29331.1	50642.4	52236.2	54846.6	55714.5

Table 47. Summary of aquaculture area in the west coast of Korea for last 10 years

(unit: ha)

Kind	Year									
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Finfish	1003.0	1105.0	1142.8	1194.8	1252.1	1156.3	1259.5	1375.86	1575.9	1196.8
Crustacean	1149.0	1358.0	1099.0	1156.0	960.0	1040.0	1420.6	1672.0	1448.3	1642.4
Shellfish	9474.0	8574.0	8334.0	8844.3	9149.6	9829.3	10189.8	10830.3	10908.4	10704.1
Seaweed	20121.0	18541.0	18099.0	17697.0	17390.0	17261.5	16985.5	17112.0	16883.0	16913.0
Others	184.0	184.0	76.5	76.5	59.0	44.0	187.0	105.0	60.0	117.2
Collective farms	ND	ND	ND	ND	ND	ND	20600.0	21141.0	23971.0	25141.0
Total	**31931.0**	**29462.0**	**28751.3**	**28968.6**	**28810.7**	**29331.1**	**50642.4**	**52236.2**	**54846.6**	**55714.5**

- Annual change of aquaculture methods (habitats) of marine farmed organisms from 1995 to 2004

Table 48. Aquaculture methods of the west coast of Korea in 1995 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	**Gyeonggi**	**Chungnam**	**Jeonbuk**	**Jeonnam**	**total**
Finfish		Land-based tank culture						
		Pond culture	105.0	1.0	217.0	258.0	241.0	822.0
		Cage culture	3.0	3.0	74.0	20.0	81.0	181.0
		Other methods						
		subtotal	108.0	4	291	278	322	1003
Crustacean		Pond culture	95.0	18.0	951.0	64.0	21.0	1149
		subtotal	95	18	951	64	21	1149
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	435.0	300.0	2711.0	4788.0	1240.0	9474
Seaweed		Floating net method	814.0	719.0	4388.0	5097.0	8677.0	19695.0
		Long-lined method	22.0	0.0	22.0	70.0	175.0	289.0
		Other methods	0.0	0.0	0.0	0.0	137.0	137.0
		subtotal	836.0	719.0	4410.0	5167.0	8989.0	20121.0
Others	Sea cucumber	Pond culture	0.0	0.0	21.0	95.0	0.0	116.0
	Polychaetes	Pond culture	0.0	0.0	40.0	0.0	28.0	68.0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	0.0	0.0	0.0	0.0	0.0
		subtotal	0.0	0.0	61.0	95.0	28.0	184.0
Collective farms		Bottom culture	ND	ND	ND	ND	13790.0	13790.0
		subtotal	ND	ND	ND	ND	13790.0	13790.0
Total			**1474.0**	**1041.0**	**8424.0**	**10392.0**	**24390.0**	**45721.0**

Note. Local government collected data on total area of shellfish, not each shellfish species except 2004. In 2004 only, they have data on farmed area of each shellfish species

Table 49. Aquaculture methods of the west coast of Korea in 1996 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish		Land-based tank culture						
		Pond culture	105.0	1.0	205.0	337.0	280.0	928.0
		Cage culture	6.0	3.0	65.0	22.0	81.0	177.0
		Other methods						
		subtotal	111.0	4.0	270.0	359.0	361.0	1105.0
Crustacean		Pond culture	211.0	27.0	955.0	135.0	30.0	1358.0
		subtotal	211.0	27.0	955.0	135.0	30.0	1358.0
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	475.0	711.0	2906.0	3159.0	1323.0	8574.0
Seaweed		Floating net method	708.0	719.0	3445.0	4360.0	8823.0	18055.0
		Long-lined method	46.0	0.0	42.0	40.0	142.0	270.0
		Other methods	0.0	0.0	0.0	0.0	216.0	216.0
		subtotal	754	719	3487	4400	9181	18541.0
Others	Sea cucumber	Pond culture	0.0	0.0	21.0	95.0	0.0	116.0
	Polychaetes	Pond culture	0.0	0.0	40.0	0.0	28.0	68.0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	0.0	0.0	0.0	0.0	0.0
		subtotal	0.0	0.0	61.0	95.0	28.0	184.0
Collective farms		Bottom culture	ND	ND	ND	ND	11933.0	11933.0
		subtotal	ND	ND	ND	ND	11933.0	11933.0
Total			**1551.0**	**1461.0**	**7679.0**	**8148.0**	**22856.0**	**41695.0**

Table 50. Aquaculture methods of the west coast of Korea in 1997 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish		Land-based tank culture						
		Pond culture	69.0	27.0	211.0	340.0	293.0	940.0
		Cage culture	6.0	9.0	72.0	21.0	94.8	202.8
		Other methods						
		subtotal	75.0	36.0	283.0	361.0	387.8	1142.8
Crustacean		Pond culture	223.0	0.0	780.0	77.0	19.0	1099.0
		subtotal	223.0	0.0	780.0	77.0	19.0	1099.0
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	657.0	254.0	2691.0	3086.0	1646.0	8334.0
Seaweed		Floating net method	788.0	779.0	3844.0	2825.0	9369.0	17605.0
		Long-lined method	47.0	0.0	42.0	40.0	144.0	273.0
		Other methods	0.0	0.0	0.0	0.0	221.0	221.0
		subtotal	835.0	779.0	3886.0	2865.0	9734.0	18099.0
Others	Sea cucumber	Pond culture	0.0	0.0	9.0	0.0	0.0	9.0
	Polychaetes	Pond culture	0.0	0.0	40.0	0.0	27.5	67.5
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	0.0	0.0	0.0	0.0	0.0
		subtotal	0.0	0.0	49.0	0.0	27.5	76.5
Collective farms		Bottom culture	ND	ND	ND	ND	12376.0	12376.0
		subtotal	ND	ND	ND	ND	12376.0	12376.0
Total			**1790.0**	**1069.0**	**7689.0**	**6389.0**	**24190.3**	**41127.3**

Table 51. A**quaculture** methods of the **west coast of Korea** in 1998 **(unit: ha)**

Kind		**Habitat(methods)**	**Province**					
			Incheon	**Gyeonggi**	**Chungnam**	**Jeonbuk**	**Jeonnam**	**total**
Finfish		Land-based tank culture						
		Pond culture	35.0	27.0	211.0	376.0	351.6	1000.6
		Cage culture	6.0	6.0	74.0	26.0	82.2	194.2
		Other methods						
		subtotal	41.0	33.0	285.0	402.0	433.8	1194.8
Crustacean		Pond culture	231.0	0.0	783.0	123.0	19.0	1156.0
		subtotal	231.0	0.0	783.0	123.0	19.0	1156.0
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	760.0	338.0	2801.0	3083.0	1862.3	8844.3
Seaweed		Floating net method	770.0	338.0	3791.0	2814.0	9490.0	17203.0
		Long-lined method	47.0	0.0	47.0	40.0	139.0	273.0
		Other methods	0.0	0.0	0.0	0.0	221.0	221.0
		subtotal	817.0	338.0	3838.0	2854.0	9850.0	17697.0
Others	Sea cucumber	Pond culture	0.0	0.0	9.0	0.0	0.0	9.0
	Polychaetes	Pond culture	0.0	0.0	40.0	0.0	27.5	67.5
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	0.0	0.0	0.0	0.0	0.0
		subtotal	0.0	0.0	49.0	0.0	27.5	76.5
Collective farms		Bottom culture	ND	ND	ND	ND	12067.0	12067.0
		subtotal	ND	ND	ND	ND	12067.0	12067.0
Total			**1849.0**	**709.0**	**7756.0**	**6462.0**	**24259.6**	**41035.6**

Table 52. Aquaculture methods of the west coast of Korea in 1999 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish		Land-based tank culture						
		Pond culture	62.0	27.0	156.0	386.0	377.6	1008.6
		Cage culture	15.0	3.0	95.0	19.0	111.5	243.5
		Other methods						0.0
		subtotal	77.0	30.0	251.0	405.0	489.1	1252.1
Crustacean		Pond culture	221.0	0.0	647.0	73.0	19.0	960.0
		subtotal	221.0	0.0	647.0	73.0	19.0	960.0
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	773.0	306.0	2838.0	3255.0	1977.6	9149.6
Seaweed		Floating net method	746.0	338.0	3733.0	2544.0	9445.0	16806.0
		Long-lined method	47.0	0.0	117.0	30.0	161.0	355.0
		Other methods	0.0	0.0	0.0	0.0	229.0	229.0
		subtotal	793.0	338.0	3850.0	2574.0	9835.0	17390.0
Others	Sea cucumber	Pond culture	0.0	0.0	13.0	0.0	0.0	13.0
	Polychaetes	Pond culture	0.0	0.0	30.0	0.0	15.0	45.0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	0.0	1.0	0.0	0.0	1.0
		subtotal	0.0	0.0	44.0	0.0	15.0	59.0
Collective farms		Bottom culture	ND	ND	ND	ND	12557.0	12557.0
		subtotal	ND	ND	ND	ND	12557.0	12557.0
Total			**1864.0**	**674.0**	**7630.0**	**6307.0**	**24892.7**	**41367.7**

Table 53. Aquaculture methods of the west coast of Korea in 2000 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish		Land-based tank culture						
		Pond culture	167.0	21.0	167.0	156.0	377.5	888.5
		Cage culture	7.0	7.0	100.0	13.0	140.8	267.8
		Other methods						
		subtotal	174.0	28.0	267.0	169.0	518.3	1156.3
Crustacean		Pond culture	98.0	6.0	636.0	281.0	19.0	1040.0
		subtotal	98.0	6.0	636.0	281.0	19.0	1040.0
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	1132.0	373.0	2929.0	3321.0	2074.3	9829.3
Seaweed		Floating net method	583.0	430.0	3714.0	2523.0	9393.0	16643.0
		Long-lined method	67.0	0.0	117.0	0.0	183.0	367.0
		Other methods	0.0	0.0	0.0	0.0	251.5	251.5
		subtotal	650.0	430.0	3831.0	2523.0	9827.5	17261.5
Others	Sea cucumber	Pond culture	0.0	0.0	13.0	0.0	0.0	13.0
	Polychaetes	Pond culture	0.0	0.0	30.0	0.0	0.0	30.0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	0.0	1.0	0.0	0.0	1.0
		subtotal	0.0	0.0	44.0	0.0	0.0	44.0
Collective farms		Bottom culture	ND	ND	ND	ND	13037.4	13037.4
		subtotal	ND	ND	ND	ND	13037.4	13037.4
Total			**2054.0**	**837.0**	**7707.0**	**6294.0**	**25476.5**	**42368.5**

Table 54. Aquaculture methods of the west coast of Korea in 2001 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish		Land-based tank culture	1.8	0.0	0.5	2.6	15.2	20.1
		Pond culture	178.4	21.0	173.8	158.2	418.2	949.6
		Cage culture	7.0	7.0	116.0	16.0	143.8	289.8
		Other methods						
		subtotal	187.2	28.0	290.3	176.8	577.2	1259.5
Crustacean		Pond culture	201.2	121.6	667.4	384.5	45.9	1420.6
		subtotal	201.2	121.6	667.4	384.5	45.9	1420.6
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	1553.2	145.0	3143.3	3318.0	0.0	8159.5
Seaweed		Floating net method	534.0	370.0	3411.0	2625.0	9388.0	16328.0
		Long-lined method	69.0	0.0	139.0	0.0	183.0	391.0
		Other methods	0.0	0.0	0.0	10.0	256.5	266.5
		subtotal	603.0	370.0	3550.0	2635.0	9827.5	16985.5
Others	Sea cucumber	Pond culture	0.0	0.0	31.0	0.0	0.0	31.0
	Polychaetes	Pond culture	0.0	0.0	25.0	0.0	5.0	30.0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	125.0	1.0	0.0	0.0	126.0
		subtotal	0.0	125.0	57.0	0.0	5.0	187.0
Collective farms		Bottom culture	1274.0	519.0	3993.0	1190.0	13624.0	20600.0
		subtotal	1274.0	519.0	3993.0	1190.0	13624.0	20600.0
Total			**3818.6**	**1308.6**	**11701.0**	**7704.3**	**24079.6**	**48612.1**

Table 55. Aquaculture methods of the west coast of Korea in 2002 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish		Land-based tank culture	2.4	0.4	0.5	2.1	24.0	29.4
		Pond culture	332.1	21.8	166.8	95.0	439.8	1055.5
		Cage culture	5.0	7.0	119.0	15.0	145.0	291.0
		Other methods						
		subtotal	339.5	29.2	286.3	112.1	608.7	1375.9
Crustacean		Pond culture	63.7	242.2	744.0	407.6	214.5	1672.0
		subtotal	63.7	242.2	744.0	407.6	214.5	1672.0
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	1610.9	503.0	3287.3	3372.0	2057.1	10830.3
Seaweed		Floating net method	528.0	904.0	3176.0	2410.0	9383.0	16401.0
		Long-lined method	97.0	0.0	166.0	0.0	190.0	453.0
		Other methods	0.0	0.0	10.0	10.0	238.0	258.0
		subtotal	625.0	904.0	3352.0	2420.0	9811.0	17112.0
Others	Sea cucumber	Pond culture	0.0	0.0	31.0	0.0	0.0	31.0
	Polychaetes	Pond culture	0.0	0.0	25.0	0.0	5.0	30.0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	43.0	1.0	0.0	0.0	44.0
		subtotal	0.0	43.0	57.0	0.0	5.0	105.0
Collective farms		Bottom culture	1131.0	853.0	4329.0	1204.0	13624.0	21141.0
		subtotal	1131.0	853.0	4329.0	1204.0	13624.0	21141.0
Total			**3770.1**	**2574.4**	**12055.6**	**7515.7**	**26320.3**	**52236.2**

Table 56. Aquaculture methods of the west coast of Korea in 2003 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish		Land-based tank culture	0.6	0.0	0.4	1.3	24.8	27.1
		Pond culture	160.0	15.1	179.0	455.0	427.8	1236.9
		Cage culture	5.0	7.0	118.0	36.0	146.0	312.0
		Other methods						
		subtotal	165.6	22.1	297.4	492.3	598.5	1575.9
Crustacean		Pond culture	217.0	184.0	435.0	418.0	194.3	1448.3
		subtotal	217.0	184.0	435.0	418.0	194.3	1448.3
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	ND	ND	ND	ND	ND	ND
		Bottom culture(clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND
		cage culture(abalone)	ND	ND	ND	ND	ND	ND
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND
		subtotal	1463.1	615.0	3405.5	3341.3	2083.5	10908.4
Seaweed		Floating net method	579.0	834.0	3041.0	2436.0	9221.0	16111.0
		Long-lined method	125.0	0.0	202.0	0.0	187.0	514.0
		Other methods	0.0	0.0	10.0	10.0	238.0	258.0
		subtotal	704.0	834.0	3253.0	2446.0	9646.0	16883.0
Others	Sea cucumber	Pond culture	0.0	0.0	23.0	0.0	0.0	23.0
	Polychaetes	Pond culture	0.0	0.0	0.0	0.0	5.0	5.0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	0.0	12.0	1.0	19.0	32.0
		subtotal	0.0	0.0	35.0	1.0	24.0	60.0
Collective farms		Bottom culture	1591.0	2788.0	4650.0	1204.0	13738.0	23971.0
		subtotal	1591.0	2788.0	4650.0	1204.0	13738.0	23971.0
Total			**4140.7**	**4443.1**	**12075.9**	**7902.6**	**26284.3**	**54846.6**

Table 57. Aquaculture methods of the west coast of Korea in 2004 (unit: ha)

Kind		Habitat(methods)	Province					
			Incheon	Gyeonggi	Chungnam	Jeonbuk	Jeonnam	total
Finfish		Land-based tank culture	0.1	0.4	0.4	0.3	23.6	24.8
		Pond culture	214.7	26.3	184.5	77.0	387.2	889.7
		Cage culture	5.0	7.0	118.0	8.0	144.3	282.3
		Other methods						
		subtotal	219.8	33.7	302.9	85.3	555.1	1196.8
Crustacean		Pond culture	99.3	139.6	752.6	398.4	252.5	1642.4
		subtotal	99	140	753	398	252.5	1642.4
Shellfish		Hanging culture (scallop, oyester, abalone, mussel etc)	187.0	163.0	313.0	10.0	191.5	864.5
		Bottom culture(clam, oyster, abalone etc)	1309.0	470.0	2822.0	3165.0	1883.5	9649.5
		cage culture(abalone)	19.0	0.0	5.0	1.0	137.0	162.0
		Land-based tank culture(abalone)	0.2	0.0	0.3	0.0	27.6	28.1
		subtotal	1515	633	3140	3176	2239.6	10704.1
Seaweed		Floating net method	427.0	799.0	3155.0	2552.0	9108.0	16041.0
		Long-lined method	132.0	0.0	207.0	0.0	273.5	612.5
		Other methods	0.0	0.0	10.0	10.0	239.5	259.5
		subtotal	559	799	3372	2562	9621.0	16913.0
Others	Sea cucumber	Pond culture	0.0	0.0	25.0	50.0	0.0	75.0
	Polychaetes	Pond culture	0.0	0.0	0.0	0.0	0.0	0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0
	Others		16.2	0.0	6.0	12.5	7.4	42.1
		subtotal	16	0	31	63	7.4	117.1
Collective farms		Bottom culture	1638.0	3621.0	4576.0	1361.0	13945.0	25141.0
		subtotal	1638	3621	4576	1361	13945.0	25141.0
Total			**4047.5**	**5226.3**	**12174.8**	**7645.2**	**26620.6**	**55714.4**

- Changes of aquaculture methods of marine farmed organisms during last 10 years

Table 58. Overview of aquaculture methods (habitats) in the west coast of Korea for last 10 years (unit: ha)

Kind		Habitat(methods)	Year										
			1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	total
Finfish		Land-based tank culture							20.1	29.4	27.1	24.8	101.3
		Pond culture	822.0	928.0	940.0	1000.6	1008.6	888.5	949.6	1055.5	1236.9	889.7	9719.3
		Cage culture	181.0	177.0	202.8	194.2	243.5	267.8	289.8	291.0	312.0	282.3	2441.4
		Other methods											
		subtotal	1003.0	1105.0	1142.8	1194.8	1252.1	1156.3	1259.5	1375.9	1575.9	1196.8	12262.1
Crustacean		Pond culture	1149.0	1358.0	1099.0	1156.0	960.0	1040.0	1420.6	1672.0	1448.3	1642.4	12945.3
		subtotal	1149.0	1358.0	1099.0	1156.0	960.0	1040.0	1420.6	1672.0	1448.3	1642.4	12945.3
Shellfish		Hanging culture (scallop, oyester, abalone, mussel)	ND	ND	ND	ND	ND	ND	ND	ND	ND	864.5	864.5
		Bottom culture (clam, oyster, abalone etc)	ND	ND	ND	ND	ND	ND	ND	ND	ND	9649.5	9649.5
		cage culture(abalone)	ND	ND	ND	ND	ND	ND	ND	ND	ND	162.0	162.0
		Land-based tank culture(abalone)	ND	ND	ND	ND	ND	ND	ND	ND	ND	28.1	28.1
		subtotal	9474.0	8574.0	8334.0	8844.3	9149.6	9829.3	10189.8	10830.3	10908.4	10704.1	96837.8
Seaweed		Floating net method	19695.0	18055.0	17605.0	17203.0	16806.0	16643.0	16328.0	16401.0	16111.0	16041.0	170888.0
		Long-lined method	289.0	270.0	273.0	273.0	355.0	367.0	391.0	453.0	514.0	612.5	3797.5
		Other methods	137.0	216.0	221.0	221.0	229.0	251.5	266.5	258.0	258.0	259.5	2317.5
		subtotal	20121.0	18541.0	18099.0	17697.0	17390.0	17261.5	16985.5	17112.0	16883.0	16913.0	177003.0
Others	Sea cucumber	Pond culture	116.0	116.0	9.0	9.0	13.0	13.0	31.0	31.0	23.0	75.0	436.0
	Polychaetes	Pond culture	68.0	68.0	67.5	67.5	45.0	30.0	30.0	30.0	5.0	0.0	411.0
	sea urchin	Bottome culture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Others		0.0	0.0	0.0	0.0	1.0	1.0	126.0	44.0	32.0	42.1	246.1
		subtotal	184.0	184.0	76.5	76.5	59.0	44.0	187.0	105.0	60.0	117.1	1093.1
Collective farms		Bottom culture	13790.0	11933.0	12376.0	12067.0	12557.0	13037.4	20600.0	21141.0	23971.0	25141.0	166613.4
		subtotal	13790.0	11933.0	12376.0	12067.0	12557.0	13037.4	20600.0	21141.0	23971.0	25141.0	166613.4
Total			**45721.0**	**41695.0**	**41127.3**	**41035.6**	**41367.7**	**42368.5**	**50642.4**	**52236.2**	**54846.6**	**55714.4**	**466754.7**

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13 ANNEX

13.1 Persons for Data Collection:

- Fisheries

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- Mariculture

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- Socio-economic

Dr. Gab Yong Jeong and Hyo Jung Kim, Korean Maritime Institute
Dr. Do Hun Kim, NFRDI
Dr. Gyu Jin Seok, MOMAF

13.2 List of species names in Korean

- Fisheries

Table 59. List of fish species name of Korean fisheries

Kind	Scientific Name	Common Name	Korean Name	Chinese Name
Fish	*Larimichthys polyactis*	Small yellow croaker	참조기	
	Scomberomorus niphonius	Spanish mackerel	삼치	
	Engraulis japonicus	Anchovy	멸치	
	Scomber japonicus	Chub mackerel	고등어	
	Trichiurus lepturus	Largehead hairtail	갈치	
	Clupea pallasii	Pacific herring	청어	
	Ammodytes personatus	Sandlance	까나리	
	Acetes chinensis And *A. japonicus*	Acetes	젓새우	
	Fenneropenaeus chinensis	Fleshy prawn	대하	
	Todarodes pacificus, *Loligo* sp. And *Sepia* sp.	Squids	오징어	

- Mariculture

Table 60. List of fish species name of Korean mariculture

Kind	Scientific name	common name	Korean name	Chinese name
	Paralichthys olivaceus	oliver founder	넙 치 류	
	Lateolabrax spp.	sea bass	농어류	
	Epinephelus septemfasciatus	seven-band grouper	능 성 어	
	Acanthopagrus schlegelii	black sea bream	감 성 돔	
	Oplegnathus fasciatus	rock bream	돌 돔	
	Pagrus major	red sea bream	참 돔	
	Other sea breams	other sea bream	기타돔류	
	Miichthys miiuy	brown croaker	민 어	
	Sciaenops ocellatus	red drum	홍 민 어	
Fish	*Seriola quinqueradiata*	yellow tail	방 어	
	Takifugu spp.	puffers	복 어 류	
	Sebastes schlegeli	jacopever	조피볼락	
	Other rock fishes	other rock fishes	기타볼락	
	Mugil spp.	mullets	숭 어 류	
	Pleurogrammus azonus	Atka mackerel	임연수어	
	Konosirus punctatus	dotted gizzard shad	전 어	
	Stephanolepis sp.; Thamnaconus sp	file fishes	쥐 치 류	
	Other fishes	other fishes	기타어류	
			subtotal	
	Fenneropenaeus chinensis	Fleshy prawn	대하	
Crustaceans	*Marsupenaeus japonicus*	Kuruma prawn	보리새우	
			subtotal	
	Crassostrea gigas	Pacific oyester	굴	
	Rapana venosa	Murex shell	소라고둥	
	Haliotis discus hannai	abalone	전 복	
	Chlamys farreri nipponensis	scallop	가 리 비	
	Cyclina sinensis	Venus clam	가 무 락	
	Mactra chinensis	Chinese mactra	개량조개	
	Scapharca subcrenata	granular ark	고 막	
Shellfish	*Solen spp.*	Gould's jacknife clam	맛 류	
	Ruditapes philippinarum	short necked clam	바 지 락	
	Meretrix lusoria	hard clam	백 합	
	Atrina pectinata	comb pen shell	키 조 개	
	Scapharca broughtonii	ark shell	피 조 개	
	Mactra veneriformis	surf clam	동 죽	
	Mytilus spp.	hard shelled mussel	홍 합	
	Others	other shellfishes	기타패류	
			subtotal	
	Porphyra spp.	laver	김류	
	Laminaria japonica	kelp	다시마류	
	Undaria pinnatifida	sea mustard	미 역	
	Gelidium amansii	Agar agar	우무가사리	
	Gigartina spp.	other agars	기타가사리	
Seaweeds	*Codium fragile*	sea staghorn	청 각	
	Hizikia fusiforme	fusiforme	톳	
	Enteromorpha spp.	sea lattuce	파 래	
	Sargassum fulvellum	gulf weed	모자반	
	Others	other seaweeds	기타해조류	
			subtotal	
	Halocynthia roretzi	sea squirt	우렁쉥이	
Others	*Stichopus japonicus*	sea cucumber	해삼	
	Styela clava	tunicates	미더덕	
		polychaetes	갯지렁이	